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GUIDELINES AND SPECIFICATIONS FOR

OIL-GAS

exploration and
development of

**NATIONAL FOREST
LANDS**



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GUIDELINES AND SPECIFICATIONS
FOR OIL AND GAS EXPLORATION
AND DEVELOPMENT ON NATIONAL
FOREST SYSTEM LANDS

U.S. DEPT. OF AGRICULTURE
NATIONAL FOREST SYSTEM

1

CATALOGING PREP.

Prepared By:
Custer National Forest
Billings, Montana
1972

INTRODUCTION

During this time of concern for our environment, it is important that the oil and gas companies and the Forest Service have a mutually agreed upon understanding of what is required to protect the environment and surface resources existing on the National Forests. We believe these guidelines will serve as a firm basis upon which to operate. Detailed specifications are also provided for most surface operations that may occur on the National Forests. These guidelines and specifications, located in one place, will serve both industry and Forest Service administrators and should result in a quality land management operation on the National Forests.

These guidelines and specifications have been circulated to industry for comment. Comments have been received from Humble Oil and Refining Company, Rocky Mountain Oil and Gas Association, Montana Petroleum Association, Montana Geological Society, Shell Oil Company, Texaco, Inc., U. S. Geological Survey, and the Bureau of Land Management. These recommendations have been carefully reviewed and incorporated wherever possible.

The list of reference materials is not included. The cost of these is approximately \$10 per set, and they should be acquired for use of the Districts having heavy oil and gas activity.

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unit

abbreviations and
definitions

PART I

ABBREVIATIONS AND DEFINITIONS

ABBREVIATIONS

AASHO - American Association of State Highway Officials

ASTM - American Society for Testing and Materials

ACI - American Concrete Institute

API - American Petroleum Institute

ANSI - American National Standards Institute

DOT - Department of Transportation

FSM - Forest Service Manual

DEFINITIONS

Operator. The individual, partnership, or corporation undertaking the execution of work on leased or permitted National Forest System Lands or its designated agents, subcontractors, or employees.

National Forest System Lands. All lands administered by the U. S. Forest Service, Department of Agriculture.

Forest Development Transportation System.

a. Facilities wholly or partly within or adjacent to and serving the National Forests, National Grasslands, or Land Utilization Projects.

b. Facilities designated by the Regional Forester constitute parts of the Forest Development Transportation System.

District Ranger. Forest Service Officer in charge of a National Forest District or his representative.

Plans and Drawings. Documents which define the planned work to be accomplished on National Forest System Lands.

Base Course. Material used to reinforce subgrade or, as shown on the plans and drawings, placed on the subgrade to distribute wheel loads.

Berm. Curb or dike constructed to prevent roadway runoff water from discharging onto embankment slope.

Borrow. Material taken from other than roadway excavation.

Clearing Limits. The limits of clearing as designated on the ground, and/or shown on the drawings, unless agreed otherwise.

Construction Slash. All vegetative material associated with construction of well sites, battery sites, pipelines, and roads such as timber, brush, grubbed stumps.

Cushion. Top layer of native or imported material on unsurfaced roads which provides a reasonably uniform and usable Traveled Way. The material is relatively free of vegetative matter and oversized rocks so that the roadbed can be maintained under traffic.

Embankment. A structure of soil, aggregate, or rock material placed on the prepared ground surface to construct subgrade.

Excess Excavation. Excavated material excess to that needed to construct the road to the typical cross section.

Noncombustible Debris. Noncombustible rubbish and other objectionable material, other than rock, associated with construction of well sites, battery sites, pipelines, and roads.

Pavement. Material such as asphalt concrete or similar material placed on Base Course, for purpose of providing a permanent, smooth, hard-running surface which does not require regular blade maintenance to retain shape and condition. Dust palliative treatments are not considered as pavement.

Pioneer Road. Temporary access for road construction built within the construction limits of the project.

Right-of-Way. Land, property, or interest therein, usually a strip, acquired for or used for a pipeline or road-related facilities.

Roadbed. The portion of a road between the intersection of subgrade and side slopes, excluding that portion of the ditch below subgrade.

Roadway. The portion of the road within the limits of excavation and embankment.

Temporary Road. A road which will be used as temporary access for pipeline construction, or as temporary access to an exploration site or drilling site. This type of road will usually not be surfaced and may only consist of a trail over natural sod. Roads of this type will not be included in the Forest Development Transportation System and will be obliterated immediately after use.

Permanent Non-System Road. A permanent access, administrative, or haul road which may or may not be surfaced. This type of road will not be included in the Forest Development Transportation System.

Permanent System Road. A permanent access, administrative, or haul road which is included in the Forest Development Transportation System. This type of road will generally be surfaced.

Subgrade. Top surface of roadbed upon which base course and surface course are constructed. For roads without base course and surface course, that portion of roadbed prepared as the finished wearing surface.

Supplemental Specifications. Special specifications developed to meet a particular need, not adequately covered by other specifications.

Surface Course. The material placed on base course or subgrade primarily to resist abrasion and the adverse effects of climate. Surface course is shown on plans and drawings.

Turnouts. That portion of the traveled way constructed as additional width on single-lane roads to allow for safe passing of vehicles.

Traveled Way. That portion of roadway used for the movement of vehicles.

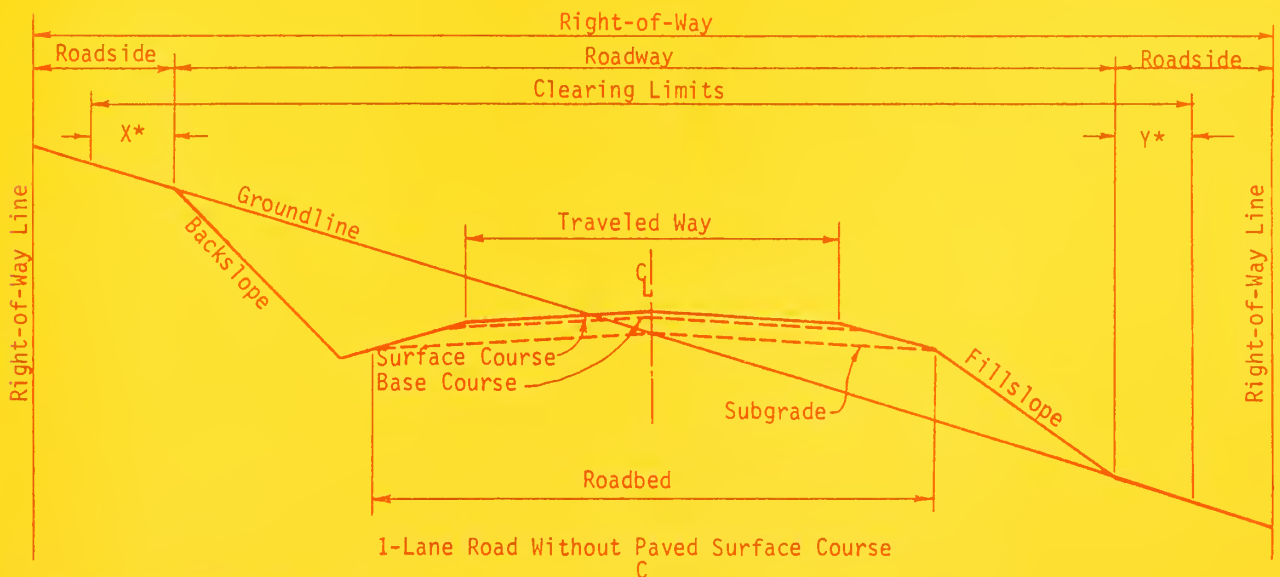
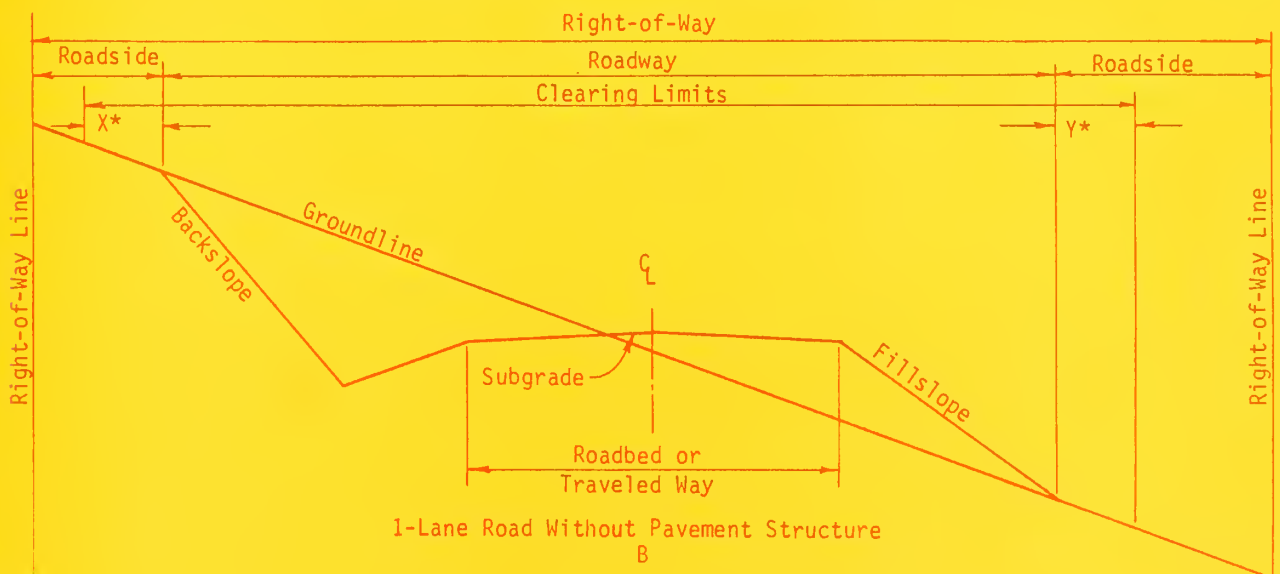
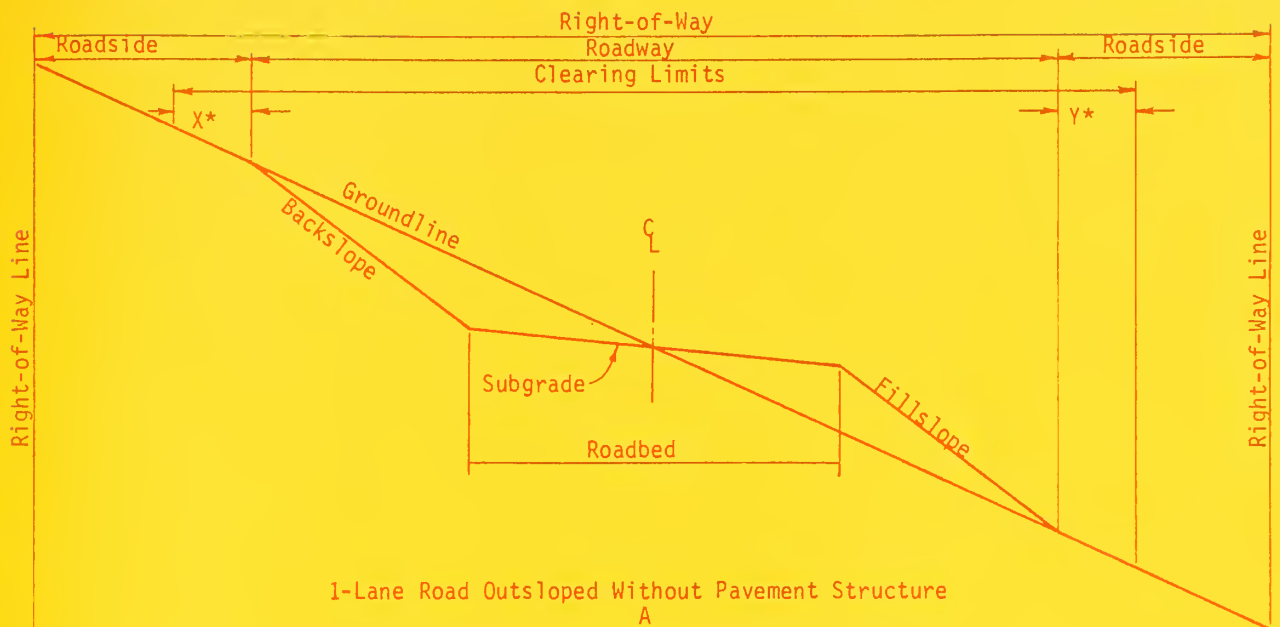
Unsuitable Excavation. Material excavated during pipeline or roadway construction which is not usable in backfill or embankment and must be disposed of, or which can be used only in certain locations or for limited purposes.

Revegetate. Establishment of vegetation, on a disturbed area, which is native and compatible to the area and its surrounding.

Rehabilitate. Restoration of a disturbed area to a near natural condition. This process may include shaping of the area, scarification, spreading of conserved surface materials, and revegetation.

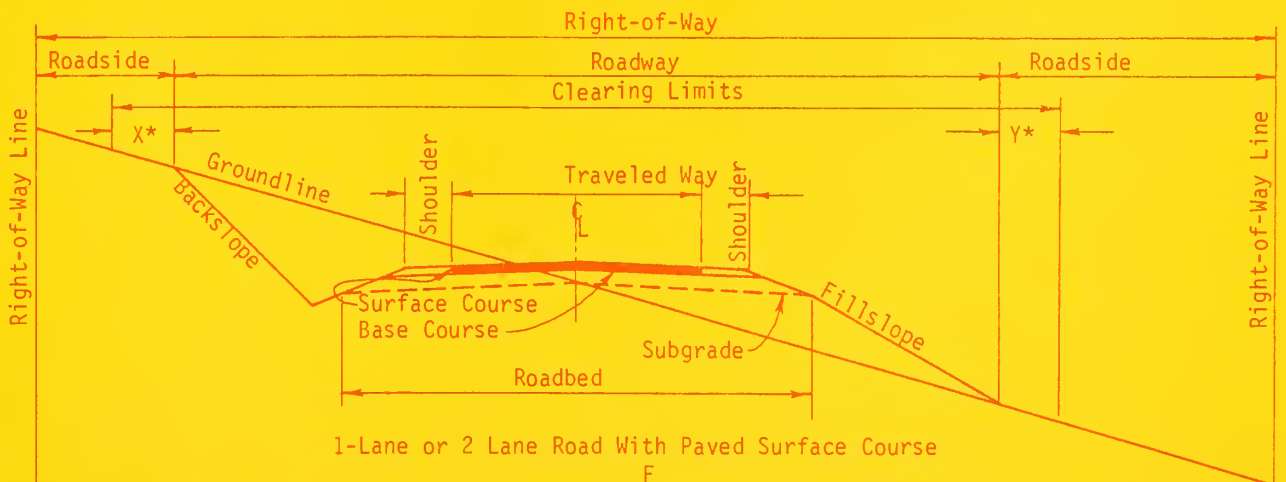
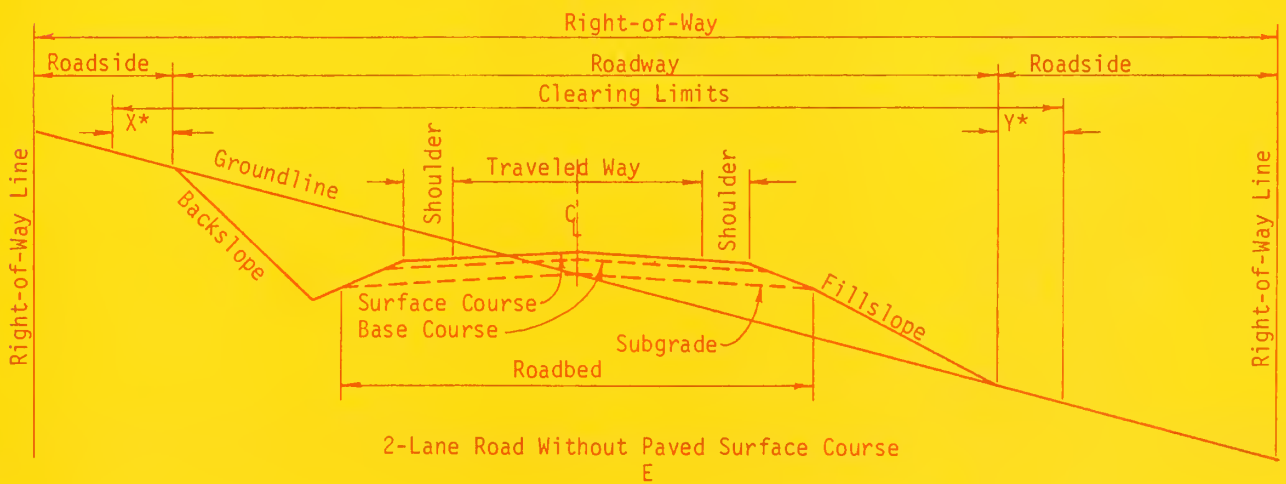
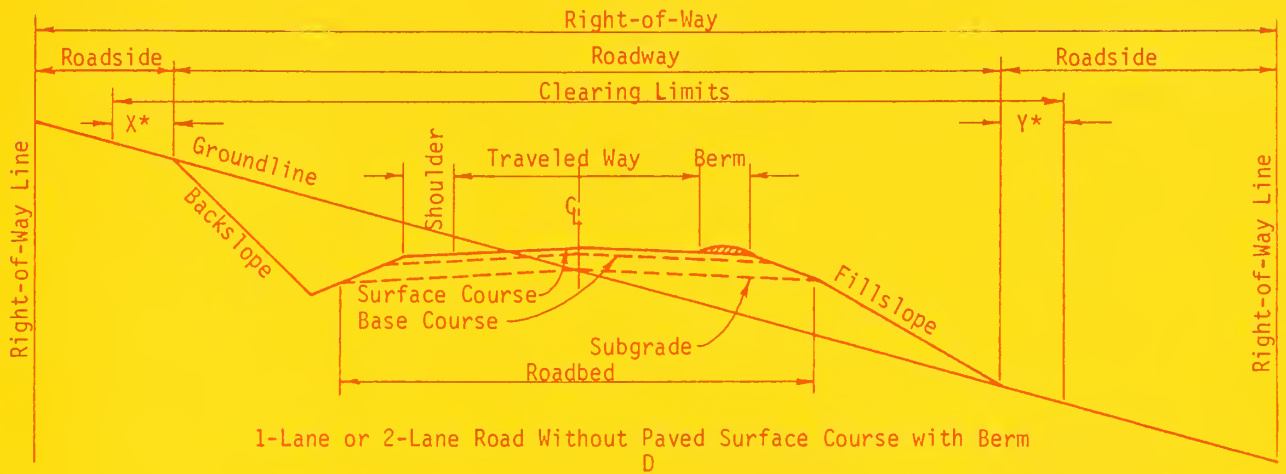


CROSS-SECTION AND ROAD STRUCTURE TERMS



* X and Y dimensions to fit local conditions.

CROSS-SECTION AND ROAD STRUCTURE TERMS



unit



guidelines

PART II

GUIDELINES

GUIDELINES

The local District Ranger shall be informed, and plans provided, a minimum of 30 days prior to the date of any field operations (such as seismic work, drilling, road construction) that involve National Forest System Lands. Every effort will be made by the Forest Service to approve these plans within 30 days. If agreement cannot be reached, the operator has the right to appeal through the normal appeals procedure. Construction and use period will be determined by soil, moisture, and ground conditions. All plans and inquiries will be submitted to the District Ranger for review and approval by the Forest Service in advance of any field operation. Surveying and staking must be approved by the Forest Service before construction of facilities is begun.

Plans and drawings to be submitted to the Forest Service for approval will vary depending on the complexity of the proposed action or project. They should be a complete graphic and/or written description of the work to be done, and the procedure or methods to be used to improve, construct, maintain, or abandon the project or facilities proposed. Sufficient detail must be shown so that the proposed project can be evaluated and the impact on National Forest resources determined. More complex projects, or certain aspects of them, will require complete detailed drawings. Roads and pipelines are examples, and the requirements for these are included in these guidelines. Below are some examples of the information which should be included in the plans:

- a. Facilities Location Maps
- b. Facilities Site Development Maps
- c. Well and Battery Site Plats
- d. Road and Pipeline Plans
- e. Construction Details
- f. Construction Schedules
- g. Rehabilitation Plans

During field operations that involve National Forest System Lands, the operator shall appoint and maintain at all times, a local agent to represent the operator, who is responsible for the operation. If a substitute agent is appointed, the operator shall immediately inform the District Ranger.

Designation shall be in writing and the agent shall have full authority to act for the operator. During construction operations, the operator shall appoint, in writing, competent personnel to inspect and supervise construction and to ensure compliance with specifications.

The Forest Service will appoint, in writing, a local representative to act as the Forest Service agent for operations that involve National Forest System Lands. This Forest Officer will have the authority to act for the Forest Service.

A construction schedule will be provided on all projects. This schedule will be subject to review and approval by the Forest Service and shall be updated as required.

Water will not be taken from any source, such as a water course, reservoir, spring, or well, without written permission of the Forest Service.

Sanitary facilities consisting of at least a pit toilet shall be utilized in camps and at construction and drilling sites.

All debris, such as explosive containers, wire, cans, pipe, cable, etc., shall be removed from construction and drilling sites and disposed of as approved by the Forest Service. Garbage will be disposed of in an approved facility.

During construction of well sites, battery sites, pipelines, and roads, topsoil and/or sufficient surface layers shall be conserved and stockpiled for use in rehabilitation operations.

Permanent structures at well sites, battery sites, and heaters shall be painted to blend with surrounding land features. Paint colors shall be approved by the Forest Service.

Powerlines serving well sites and battery sites shall be located to minimize adverse effects on the esthetics of the area.

During surveying and construction operations for well sites, battery sites, pipelines, powerlines, and roads, the operator shall protect and preserve all land survey monuments. Records of found corners and monuments shall be given to the Forest Service. Necessary forms will be supplied, as requested, by the Forest Service.

In the event of a spill from any facility, the Forest Service shall be immediately notified.

Spill cleanup operations will be reviewed by the Forest Service representative, and his recommendations for action to protect surface resource values shall be followed. The Regional Contingency Plan developed by the EPA for oil spill cleanup will be followed.

The operator shall maintain the Forest development transportation facilities he uses, as necessary, for safe and efficient utilization. The Forest Service will approve maintenance plans.

Department of Transportation regulations and specifications referred to in these guidelines and specifications apply to all facilities on National Forest System Lands.

The District Ranger will determine the need and prepare a Wildfire Plan for the operation. This plan will outline responsibilities for fire prevention and suppression activities and set up attack procedure in the event of a wildfire within the project area. The plan also specifies conditions under which construction activities will be curtailed or shut down.

unit

general requirements



PART III

GENERAL REQUIREMENTS

EXPLORATION

Methods of exploration which minimize surface damage will be used.

If drilling is necessary for exploration, the operator shall not drill within 660 feet of any building without prior written approval of the owner. Buildings or other structures owned by the operator are excluded.

If drilling is necessary for exploration, all drill cuttings on the ground surface will be spread to no more than 1 inch thickness and revegetated as directed by the Forest Service.

All drill holes shall be plugged in the following manner:

All seismic holes will be completely filled, depending upon the method of shooting, with either cuttings, a mixture of cuttings and "bentonite gel," or "bentonite gel." No concrete or metal surface plugs are to be installed. Filling back is to be done within 6 months after the hole has been drilled.

Whenever possible, the operator will drive over natural ground. If earthwork is necessary to obtain access to a site, the temporary road will be constructed in accordance with Road Specification 05--Temporary Road Construction (page 47).

Following exploration operations, sites and access roads shall be rehabilitated as directed by the Forest Service.

The permittee will furnish the District Ranger, within 15 days after completion of the exploration project, a certified copy of the operation log and plat showing evidence of the exact number of shotpoint locations utilized. Upon receipt of a satisfactory statement from the permittee, the Forest Service will calculate the fees due according to the payment schedule and will bill the permittee for this amount less the amount of the initial payment. If total deposits are in excess of the amount required as payment for all shotpoint locations, the excess will be refunded to the permittee.

WELL SITES

Location of well sites is subject to the Forest Service approval within the limitations set by State and Federal law.

The operator shall not drill within 660 feet of any building, public recreation area, administrative site, water well, or spring without prior written approval of the Forest Service or landowner. Buildings or structures owned by the operator are excluded.

The disturbed area is to be kept to the minimum necessary for drilling operations. Well sites will be staked by the operator and approved by the Forest Service.

Spoil material from site preparation shall not be deposited in natural drainageways. The lower edge of the spoil bank must be at least 5 feet above the high-water level in the drainageway. Material overcast in leveling well sites shall be compacted in 6-inch layers as it is deposited. Wherever possible, spoils material shall not be deposited in timbered areas.

Following construction of the well site, the disturbed area shall be revegetated as directed by the Forest Service.

If, in the judgment of the Forest Service, surface flow from slopes above the drill site will cause erosion of the disturbed area, contour trenches shall be built to divert such surface flow away from the site.

Sump pits must be constructed to meet the following requirements:

1. Sump pits shall be located so that surface water flows will not enter them. Preferably, they will be located on high ground, but lacking such a location, provision to divert surface flows will be made.

2. Sump pits will be excavated below the natural ground level and the excavated material diked around the edges. They shall not be filled to a depth greater than that reached at the natural ground level unless authorized by the Forest Service. (See requirements for dikes under Battery Sites.)

3. Sump pits will be filled by pushing in the dikes to mix liquid materials with soil.

4. If the sump pits cannot be buried satisfactorily, they must be pumped and the waste discharged into a suitably prepared pit and buried or otherwise suitably disposed of in accordance with Federal and State laws.

5. After burying, the restored surface of the fill material shall be rehabilitated. The Forest Service Representative will set the date for rehabilitation of sumps on an individual basis.

6. Depending upon soil structure, the sump pits shall be lined with a liner (P.V.C., sheeting, vinyl pond liners), Bentonite clay, or other suitable material as required by Federal or State law, or by the District Ranger, to prevent contamination of surface or ground water.

If the well does not prove to be a producer, the entire well site shall be rehabilitated as directed by the Forest Service.

During all phases of construction and drilling, the sump pit will be fenced. After the drilling operation is completed, the entire well site will be fenced and a gate or cattle guard provided where the access road crosses the fence if the site is hazardous to human or animal life. Road specifications 72 and 75 (pages 126 and 129) cover fence and cattle guards.

7. Where feasible, slurry tanks, instead of pits, will be used in drilling operations.

Access roads to well sites will remain temporary until the well is proved a producer. Construction of temporary and permanent access roads shall meet the requirements set forth in the road specifications.

After a well is depleted, the entire well site shall be rehabilitated as directed by the Forest Service.

BATTERY SITES

Battery sites shall be located and constructed so that they make the least impact on the environment.

A continuous dike shall be provided around the site to prevent leakage. Truck fill spouts shall be designed so that they will be within the diked area.

Dikes shall meet the following requirements, or shall be constructed in a manner suitable to the Forest Service representative.

1. They shall be constructed of impervious materials compacted in 6-inch lifts.

2. Minimum dimensions are as follows: trapezoidal cross section with a 9-foot base, 1-foot top, 2 feet high.

3. The natural ground over which the dike is to be constructed shall be scarified to ensure a good bond between the dike and the ground.

4. Gravel or scoria shall be spread on the dike to a uniform thickness of 3 inches.

The site shall be fenced after initial construction is completed. A gate or cattle guard shall be provided where the access road crosses the fence. Fences and cattle guards shall meet the requirements of Road Specifications 72 and 75 (pages 126 and 129).

PIPELINES
Liquid Petroleum, Gas, Water

Proposed pipeline locations will be located in advance by the operator, prior to the surveying operations, and approved in writing by the Forest Service Representative.

Hardwood draws, recreation areas, scenic areas, historical sites, known archeological sites, and live stream crossings should be avoided. Locations should be in corridors adjacent to existing rail lines, roads, or pipelines whenever possible.

Alignment for the pipeline should be surveyed and tied to permanent land survey monuments. Degrees of accuracy required shall be those set forth in Road Specification 10--Preliminary Survey (page 49).

A complete set of plan profile tracings shall be furnished. The tracings shall be on standard Federal Aid 23" x 36" plan profile sheets.

The plan view shall meet the following requirements:

1. Scale--1 inch equals 400 feet.
2. Show location of pipeline.
3. Show found and projected land monuments.
4. Show land grid line with ownership of each quarter section and a north arrow.
5. Show land ties from pipeline to found land monuments.
6. Show all land features such as watercourses, fences, roads, pipelines, battery sites, well sites, powerlines, risers, heaters, valves, etc.

The profile view shall meet the following requirements:

1. Scale--1 inch equals 400 feet horizontal--1 inch equals 10 feet vertical.
2. Show ground profile and pipeline profile.
3. Show all pipeline features such as risers, valves, etc.

The plans shall also contain a typical section sheet containing the following

1. Typical cross section of trench.
2. Typical support drawing for spans or surface lines.

3. Type of pipe and size.
4. Working pressure of pipe.
5. Type of material to be pumped.

If the pipeline is a surface line, it shall be buried in areas that are visible from public roads and trails.

Clearing operations shall meet the requirements set forth in API Bulletin 1105, Subsection 2.462. Disturbance of right-of-way shall be minimized as conditions will permit. Any material over 4 inches in diameter shall be removed and hauled to designated disposal areas or buried on work site or reduced in size to 4 inches or less in diameter and disposed of by scattering.

Grading of pipeline right-of-way shall meet the requirements set forth in API Bulletin 1105, Subsections 2.463 and 2.464. ANSI Bulletin B 31.4, Subsection 434.3.2a should be consulted.

Location and construction of temporary gates shall meet the specifications and requirements set forth in API Bulletin 1105, Subsection 2.461.

During ditching operations and installation of buried pipe, the open ditch shall be patrolled, when necessary, by the operator to prevent injury to persons, livestock, or game animals.

Restoration of right-of-way shall meet the requirements of API Bulletin 1105, Subsections 1.72 and 3.12. Disturbed areas shall be revegetated with grass and/or shrub species as designated by the Forest Service. The Forest Service Representative will determine the season for planting and inform the operator.

Clean-up operations shall meet the requirements of API Bulletin 1105, Subsections 1.8 and 3.2.

Watercourse crossings shall meet the requirements of API Bulletin 1105, Subsections 2.0 and 3.4 and ANSI Bulletin B 31.4, Subsection 434.14.

Pipeline monuments shall be set every $\frac{1}{2}$ mile and at every direction change. These monuments shall consist of a brass cap set on a pipe which stands 18 inches above the surface. The cap shall contain the following markings:

1. Name of company.
2. Type of pipe and material being piped.
3. Bearing of line or direction change deflection.

In the event of abandoning a pipeline, it is required that the abandonment procedures meet the requirements set forth in ANSI B 31.4, Section 455. If the operator elects to remove the line, the right-of-way shall be rehabilitated as directed by the Forest Service.

Final approval of pipeline construction will be preceded by a field review by both parties. The Forest Service will provide a formal approval of the initial construction. An as-built set of plans will be provided by the operator upon final acceptance of the construction.

ROADS

Road locations, design, and construction must reflect special efforts to assure the protection of the natural environment. This effort will be directed toward disposal of clearing slash, least practicable amount of excavation, erosion control during and after road construction, protection of natural drainage, protection of developed drainage, and other positive efforts that will contribute to a harmonious relationship between the road and its surroundings.

Proposed roads will be located on the ground in advance by the operator and approved in writing by the Forest Service prior to surveying activities.

Criteria for location, survey, design, and construction varies, depending on the type of road involved. Criteria for permanent roads is stated in Road Specifications 10, 11, and 13 (pages 49-67). Survey and design criteria for temporary roads will depend on the degree of soil disturbance envisioned after location procedures are completed. As a minimum, an Abney grade-line and field design procedures will be required where there are cuts, fills, and culvert placements involved.

Unconstructed travel routes will be treated to prevent water concentrations and resulting erosion. Water diversions will be installed as necessary to prevent erosion in wheel tracks.

Cut slopes on all types of roads shall be rounded to fit the terrain and to aid in revegetation operations.

For permanent roads, operator shall provide the preliminary design plans and applicable construction specifications, with any modification or supplementation, for review by the Forest Service prior to completion of the design to determine their compliance with the guidelines and requirements. Adjustments or modification shall be made as recommended by the Forest Service.

Roads constructed across National Forest System lands and any part of such roads constructed on lands or right-of-way owned or controlled by the operator shall be open at all times to free use by public officials in connection with their official duties.

Upon completion of a road or section of road, a final acceptance inspection report will be prepared by the Forest Service certifying whether or not the road or road portions conform to drawings, specifications, and general requirements. This report will contain recommendations for or against acceptance. Based on this report, the Forest Service will notify the operator in writing of acceptance or rejection of the road or road portion. If the road is not accepted, the Forest Service will give the operator a detailed itemization of work needed for acceptance.

After the road project has been accepted, the operator shall provide the Forest Service with a set of as-built plans.

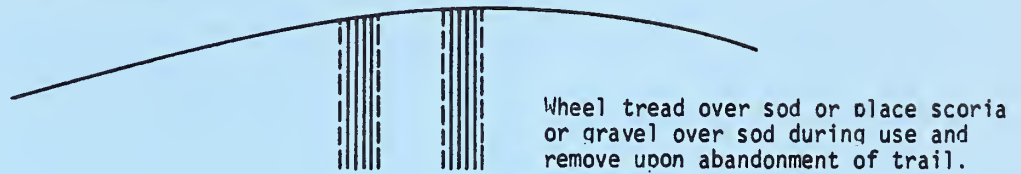
At any time the operator elects to abandon a permanent nonsystem road or the permit is terminated or cancelled, all rights, title, and interests in the road on National Forest System Lands will be vested in the United States. At the time of abandonment, the Forest Service will review the facility in terms of management needs and purposes and the road will either be added to the National Forest Transportation System or the operator will obliterate and rehabilitate the disturbed area.

Signing for roads will be determined by the Forest Service, and the signs needed will meet the requirements and specifications set forth in the "Manual On Uniform Traffic Control Devices."

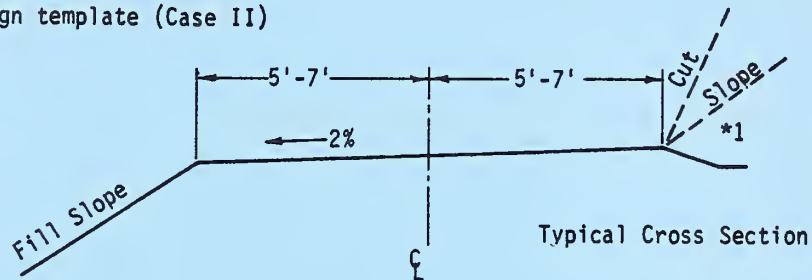
TYPICAL SECTIONS

Temporary Roads -

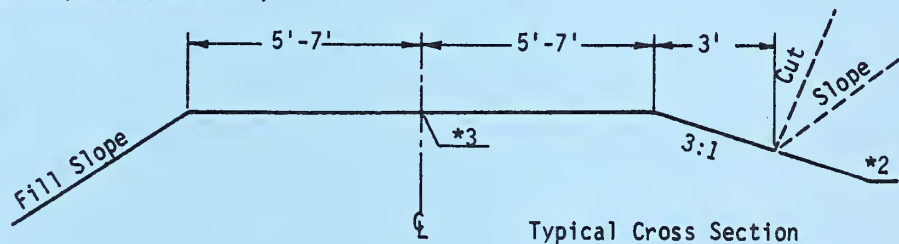
Case I - Natural Sod Trail



Road design template (Case II)



Road design template (Case III)



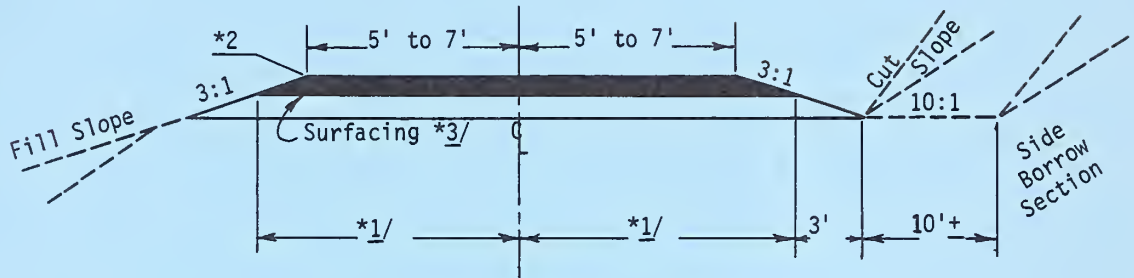
Alignment Contour Flag Line		Fill Slopes	
		Common	1 1/2:1
		Rock	1 1/2:1
Specifications that apply		Cut Slopes	
05	41	Solid Rock	1/4:1
22	72	Hardpan - Soft Rock	1/2:1
31	75	Common, Cuts over 12'	1 1/2:1
40	77	Common, Cuts under 12'	2:1
Gradient			
Maximum sustained 6%			
Maximum pitch and length of pitch as determined by the Forest Service			

1. Drainage structures will be required in draws containing live streams.
2. Cross drains will be required as designated in Specification 05.
3. Slope as directed by the Forest Service.

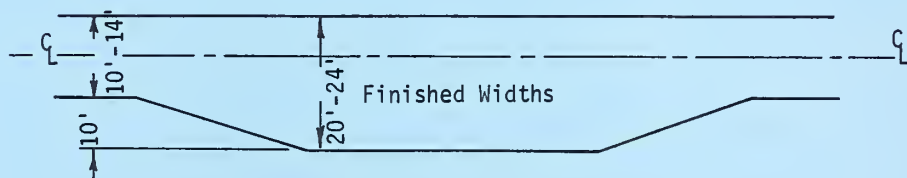
TYPICAL SECTION

Permanent Non-system Roads -

Road design standard (Single Lane with turnouts)



Typical Cross Section



Typical Turnout Plan *4/

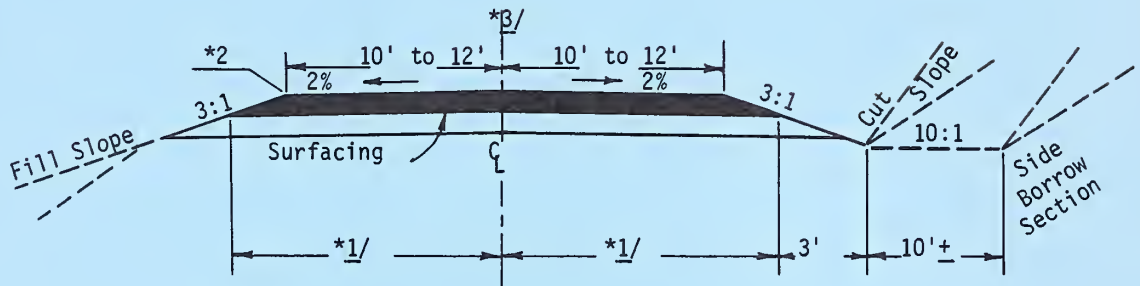
Alignment		Fill Slope	Not more than 3'	Under 6'	Over 6'
Minimum Radius	50 feet	Common	3:1	2:1	1½:1
		Rock			1½:1
Specifications that apply		Cut Slopes			
10	31 40 52 75	Solid Rock			
11	33 41 70 77	Hardpan, Soft Rock			
13	35 42 50 72 78	Common, Cuts over 12'			
16	37 43 51 73 79	Common, Cuts less than 12'			
22	80				
Gradient					
Maximum sustained		6%	Pitch grades are allowed for a maximum of 300 feet with no more than 1500' of pitch per mile		
*5 Maximum pitch		8%			

1. Subgrade width will vary depending on the depth of surfacing required.
2. Fills 1-6' high 1 foot of widening
Fills over 6' high 2 feet of widening
3. If surfacing is not used, travel will be limited to periods where subgrade is not wet.
4. Turnouts shall be constructed to ensure safety on the "empties" side where practicable.
5. Grades exceeding 8% will not be allowed unless justification is approved by the Forest Service.

TYPICAL SECTION

Permanent Non-system Roads -

Road design Standard (Double Lane)



Typical Cross Section

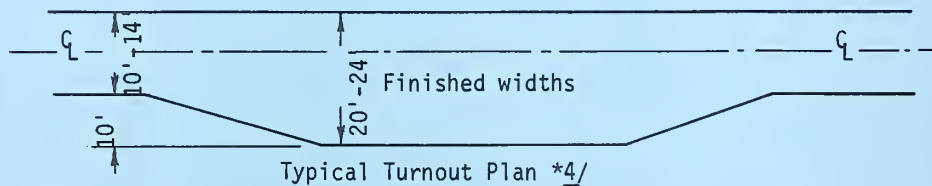
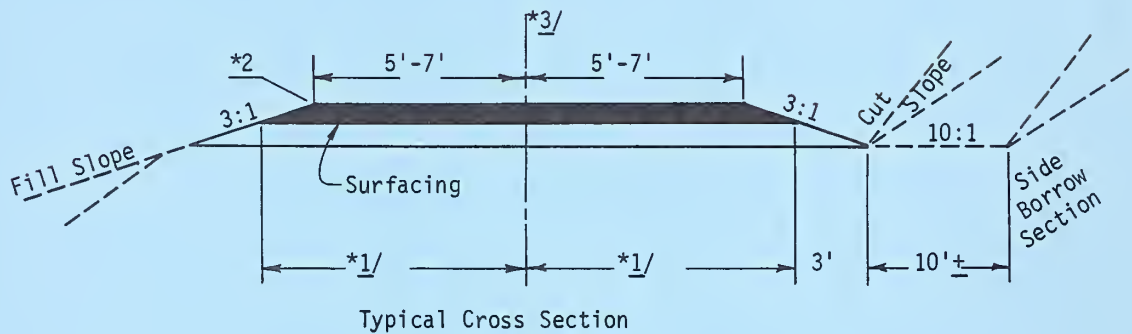
Alignment						Fill Slope	Not more than 3'	under 6'	over 6'
Minimum Radius		150 feet				common rock	3:1	2:1	1½:1 1½:1
Specifications that apply						Cut Slopes			
10	31	40	61	70	77	Solid Rock		¾:1	
11	33	41	50	62	72	Hardpan, Soft rock		½:1	
13	35	42	51	63	73	Common, Cuts over 12' high		1½:1	
16	36	43	52	64	80	Common, Cuts 6-12' high		2:1	
22	37		60	65	75	Common, Cuts under 6' high		3:1	
Gradient						Pitch grades are allowed for a maximum of 500 feet with no more than 1000' per mile			
Maximum sustained		6%							
Maximum pitch		8%							

1. Subgrade width will vary depending on the depth of surfacing required.
2. Fills 1-6' high 1 foot of widening.
Fills over 6' high 2 feet of widening.
3. Curve widening = $400 \div \text{Radius of horizontal curve (feet)}$.

TYPICAL SECTION

Permanent System Road -

Road design Standard (Single lane with turnouts)



Alignment	Minimum Radius	100 feet	Fill Slopes	Not more than 3'	under 6'	over 6'
			Common Rock	3:1	2:1	1½:1
Specifications that apply			Cut Slopes			
10	36	72	Solid Rock			
11	37	50	Hardpan, Soft Rock			
13	40	51	Common, Cuts over 12' high			
16	41	52	Common, Cuts 6-12' high			
22	42	60	Common, Cuts under 6' high			
31	43	64				
33		70				
35		80				

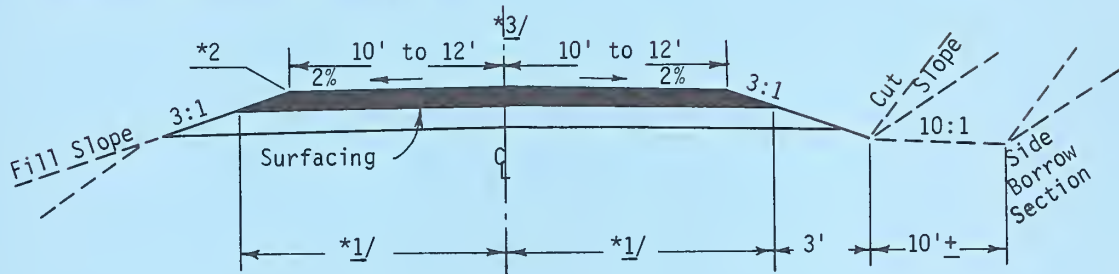
Gradient			Pitch grades are allowed for a maximum of 500 feet with no more than 1000' per mile
Maximum sustained	6%		
Maximum pitch	8%		

1. Subgrade width will vary depending on the depth of surfacing required.
2. Fills 1-6' high 1 foot of widening
Fills over 6' high 2 feet of widening
3. Curve widening = 400/Radius of horizontal curve.
4. Turnouts shall be constructed to ensure safety on the "empties" side where practicable; or, on blind curves, shall be double-tracked for the entire length of the curves or until intervisible with the next turnout.

TYPICAL SECTION

Permanent System Roads -

Road design Standard (Double Lane)



Typical Cross Section

Alignment		Fill Slope			
Minimum Radius	150 feet	common	Not more than 3'	under 6'	over 6'
Specifications that apply		rock	3:1	2:1	1½:1
10	31	Cut Slopes			
11	33	Solid Rock			
13	35	Hardpan, Soft rock			
16	36	Common, Cuts over 12' high			
22	37	Common, Cuts 6-12' high			
		Common, Cuts under 6' high			
Gradient					
Maximum sustained		Pitch grades are allowed for a maximum of 500 feet			
Maximum pitch		with no more than 1000' per mile			

1. Subgrade width will vary depending on the depth of surfacing required.
2. Fills 1-6' high 1 foot of widening.
Fills over 6' high 2 feet of widening.
3. Curve widening = $400 \div \text{Radius of horizontal curve. (Feet)}$

unit

specifications



PART IV

SPECIFICATIONS

PIPELINES

Liquid Petroleum Pipelines

Design:

1. Design Conditions. General pipeline design considerations covered in ANSI B 31.4, Section 401, shall be followed.
2. Criteria:
 - a. Steel Pipe. Design criteria shall meet the requirements of ANSI B 31.4, Section 402.
 - b. Glass Fiber Reinforced Thermosetting Resin Line Pipe. Design criteria shall meet the requirements of API Sta. 5LR, Sections 4, 5, and 6.
3. Pressure Design of Piping Components.
 - a. Steel. Section 403, ANSI 13.31.4, "Criteria for Pressure Design of Piping Components," shall be used.
 - b. Glass Fiber Reinforced Thermosetting Resin Line Pipe. Sections 4, 5, and 6 of API Sta. 5LR shall be used.
4. Design of Applications of Piping Components:
 - a. Pipe:
 - (1) Steel Pipe. Pipe shall meet the requirements of ANSI B 31.4, Subsection 405.2.
 - (2) Glass Fiber Reinforced Thermosetting Resin Line Pipe. Pipe shall meet the requirements of API Sta. 5LR, Sections 4, 5, and 6.
 - b. Fittings, Elbows, Bends, and Intersections. Pipeline fittings, elbows, bends, and intersections shall meet the requirements of ANSI B 31.4, Section 407.
 - c. Valves. Valves shall meet the requirements of ANSI B 31.4, Section 407.
 - d. Flanges, Facings, Gaskets, and Bolting. Flanges, facings, gaskets, and bolting shall meet the requirements of ANSI B 31.4, Section 408.

5. Selection and Limitation of Piping Joints. Selection and limitation of piping joints for steel pipelines shall be determined with the use of ANSI B 31.4, Sections 411, 412, 414, and 418.

6. Expansion and Flexibility:

a. Steel. Expansion and flexibility requirements shall be those stated in ANSI B 31.4, Section 419.

b. Glass Fiber Reinforced. Refer to ASTM D696-44.

7. Pipe Supporting Elements: Design of supporting elements shall meet the requirements set forth in ANSI B 31.4, Section 421. See Drawing I, Support Detail.

Materials

1. Metallic - Steel. General requirements for metallic pipe and miscellaneous parts shall be those set forth in ANSI B 31.4, Sections 423, 425, and 426.

2. Non-metallic - Glass Fiber Reinforced Thermosetting Resin. Requirements for glass fiber reinforced thermosetting resin line pipe shall be those set forth in API Sta. 5LR, Sections 2, 3, and 4.

Construction Methods

1. Handling:

a. Steel Pipe. Handling of uncoated and coated steel pipe meet the requirements of API Bulletin 1105, Subsections 2.511 and 2.512. ANSI B 31.4, Subsection 434.4 also provides guidance.

b. Glass Fiber Pipe. Care shall be exercised in handling or storing pipe in order to avoid scoring or breakage.

2. Hauling and Stringing of Pipe:

a. General Requirements. Hauling and stringing of pipe shall be as required in API Bulletin 1105, Section 2.52.

b. Steel Pipe. Hauling and stringing of steel pipe shall meet the requirements of API Bulletin 1105, Subsections 2.521 and 2.522. Damage to fabricated items and pipe is covered in ANSI B 31.4, Subsection 434.5.

3. Ditching:

a. Ditch Dimensions. Depth of pipeline ditches shall meet the requirements of DOT, Federal Regulations, Part 195, Subsection 195.248. Guidelines for ditch width are set forth in API Bulletin 1105, Subsection 1.31.

b. Clearance with underground structures. Clearance requirements are set forth in DOT, Federal Regulations, Part 195, Subsection 195.250.

c. Spans:

(1) Steel Pipe. Use of spans shall meet the requirements of API Bulletin 1105, Subsection 1.33. See Drawing I.

(2) Glass Fiber Pipe. Spans will not be allowed with this type of pipe. All installations shall be buried.

4. Laying:

a. Steel Pipe:

(1) Skids. Use of skids shall meet the requirements of API Bulletin 1105, Subsections 1.41 and 2.81.

(2) Bending. Bending of pipe shall meet the requirements of ANSI Bulletin B 31.4, Subsections 434.7.1 and 434.7.3.

(3) Welding. Welding shall be done in accordance with ANSI B 31.4, Subsection 434.8.

(4) Cleaning, priming, and coating. Cleaning, priming, and coating of pipe shall meet the requirements of API Bulletin 1105, Subsection 2.9, and DOT, Federal Regulation, Part 195, Subsections 195.236, .238, .242, and .244.

(5) Installation of pipe in ditch. Installation of pipe in ditch shall meet the requirements of API Bulletin 1105, Subsections 1.6 and 3.0. Backfill operations shall meet the requirements of API Bulletin 1105, Subsections 1.71 and 3.11. Disposal of unsuitable backfill materials will be as directed by the Forest Service Representative.

b. Glass Fiber Pipe:

(1) Installation information. Requirements for installation of glass fiber pipe shall be those set forth by the individual pipe producer.

(2) Backfill operations. Backfill operations shall meet the requirements of API Bulletin 1105, Subsection 1.71.

(3) Directions changes. Connections at elbows and tees shall have sufficient backup of compacted soil or concrete. Thrust blocks shall be used in areas of severe direction or elevation changes.

(4) Risers. Installation of risers in glass fiber pipe shall be such that injection of oil under pressure will not result in a broken joint.

Gas Pipelines

Design:

1. Steel Pipe. Design of steel pipe shall meet the requirements of Department of Transportation, Federal Register, Vol. 35, No. 161, Part 192, Subsections 192.103, 105, 107, 109, 111, 113, and 115.
2. Cast Iron Pipe. Cast iron pipe must be designed in accordance with DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.117.
3. Ductile Iron Pipe. Ductile iron pipe must be designed in accordance with DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.119.
4. Plastic Pipe. Design of plastic pipe shall meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsections 192.121 and 192.123.
5. Copper Pipe. Copper pipe design shall meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.125.
6. Pipeline Components:
 - a. Valves. Valve design shall meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.145.
 - b. Flanges and flange accessories. Flanges and accessories shall meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.147.
 - c. Tapping. Tapping requirements are set forth in DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.151.
 - d. Welded components. Welded components must meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsections 192.153 and 192.155.
 - e. Supports and anchors. Supports and anchors must meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.161.

f. Design pressure of plastic fittings. Plastic fitting must conform to DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.191.

g. Valve installation in plastic pipe. Each valve installation in plastic pipe shall meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.193.

Materials

1. General. General requirements for materials are set forth in DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.53.

2. Steel Pipe. Requirements for steel pipe are set forth in DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.55.

3. Cast Iron and Ductile Iron Pipe. Material requirements for cast or ductile iron pipe shall be those set forth in Subsection 192.57, DOT, Federal Register, Vol. 35, No. 161, Part 192.

4. Plastic Pipe. Plastic pipe shall meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 162, Subsection 192.59.

5. Copper Pipe. Copper pipe is qualified for use if it has been manufactured in accordance with an accepted specification.

Construction Methods

1. Welding of Steel in Pipelines. Welding requirements for steel are set forth in DOT, Federal Register, Vol 35, No. 161, Part 192, Subsections 192.223, 225, 227, 229, 231, 233, 235, 237, 239, 241, 243, and 245.

2. Joining of Materials Other Than by Welding. Requirements for joining materials other than by welding are set forth in DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsections 192.271, 273, 275, 277, 279, and 281.

3. Inspection of Materials Before Laying. Each length of pipe and each component must be visually inspected at the site of installation to ensure that it has not sustained any visually determinable damage.

4. Repair of Steel Pipe. Each imperfection or damage that exists shall be repaired in accordance with DOT, Federal Register, Vol 35, No. 161, Part 192, Subsection 192.309.

5. Repair of Plastic Pipe. Each imperfection or damage that exists which would impair the serviceability of the pipe shall be repaired by a patching saddle or the damaged section removed.

6. Bends and Elbows. Each field bend in steel pipe, other than a wrinkle bend, must meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.313.

7. Wrinkle Bends in Steel Pipe. Wrinkle bends in steel pipe must meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.315.

8. Installation of Pipe in a Ditch. Installation of pipe in a ditch shall be done according to the requirements set forth in DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.319.

9. Installation of Plastic Pipe. Plastic pipe must be installed below ground level, and the installation must meet the requirement of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.321.

10. Casing for Crossings. Casing used on pipelines under roads shall meet the requirements of DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.323.

11. Underground Clearance. Clearance of pipelines with other underground structures shall be as stated in DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.325.

12. Depth of Ditches and Cover. Each buried pipeline shall meet the requirements for cover set forth in DOT, Federal Register, Vol. 35, No. 161, Part 192, Subsection 192.327.

Water Pipelines

Design. Design of pipe shall meet the requirements of DOT, Federal Regulations, Part 195, Sections 195.100 through 195.132.

Construction Methods. Construction of salt and waste water pipelines shall meet the requirements of DOT, Federal Regulations, Part 195, Sections 195.200 through 195.266.

ROADS

The specifications listed below are found on the following pages:

1. Specification 05 - Temporary Road Construction
2. Specification 10 - Preliminary Survey (Permanent Roads)
3. Specification 11 - Location Survey and Construction Staking (Permanent Roads)
4. Specification 13 - Design (Permanent Roads)
5. Specification 16 - Construction Staking
6. Specification 22 - Clearing, Grubbing, and Slash Cleanup
7. Specification 31 - Roadway Excavation for Permanent Roads
8. Specification 33 - Borrow from Pits and Quarries
9. Specification 35 - Berm
10. Specification 36 - Reshape and Finish Existing Roadway
11. Specification 37 - Riprap
12. Specification 40 - Corrugated Metal Culvert
13. Specification 41 - Structural Plate Culvert
14. Specification 42 - Underdrain
15. Specification 43 - Downpipe
16. Specification 50 - Aggregate Base Course (Pit Run)
17. Specification 51 - Aggregate Base Course (Screened)
18. Specification 52 - Aggregate Base Course (Crushed)
19. Specification 60 - Oil Dust Palliative
20. Specification 61 - Bituminous Prime Coat
21. Specification 62 - Bituminous Treated Base

- 22. Specification 63 – Bituminous Surface Treatment
- 23. Specification 64 – Bituminous Seal Coat
- 24. Specification 65 – Road Mix Bituminous Surfacing
- 25. Specification 70 – Treated Timber Structures
- 26. Specification 72 – Cattleguards
- 27. Specification 73 – Metal Bin-Type Retaining Wall
- 28. Specification 75 – Fences and Gates
- 29. Specification 77 – Planting and Seeding
- 30. Specification 78 – Markers and Guideposts
- 31. Specification 79 – Construction Piling
- 32. Specification 80 – Portland Cement Concrete

SPECIFICATION 05 - TEMPORARY ROAD CONSTRUCTION

Description

1. This specification covers the work required to provide access to exploration sites and nonproducing well sites.

Construction Requirements

2.1 The location of each section of road must be approved on the ground by the Forest Service before construction or use is begun.

2.2 Whenever possible, the operator will drive over natural sod and not disturb the ground.

2.3 Where earthwork is necessary, roads conforming to the Temporary Road Design Typical Section will be constructed. Use of Case II or Case III roads is subject to Forest Service approval. Construction shall be held to an absolute minimum.

2.4 Case II road shall have suitable drainage structures installed at all drainage crossings. Case III roads shall have suitable drainage structures installed at all drainage crossings, and culvert pipes installed for cross drainage (ditch relief). Culverts and their installation shall meet the requirements of Specification 40.

2.5 Clearing, grubbing, and slash cleanup shall meet the requirements of Specification 22.

2.6 Use of borrow pits shall meet the requirements of Specification 33.

2.7 The operator will be required to construct gates or cattleguards in all fences he crosses. Gates must be kept closed. Construction of gates or cattleguards shall meet the requirements of Specification 75 or 72.

2.8 When the road is abandoned, the operator shall outslope or construct adequate diagonal barriers and drainage dips at locations authorized by the Forest Service. Spacing between the dips shall not exceed the following intervals:

<u>Sustained Grade</u>	<u>Maximum Spacing</u>
0-2%	300 feet
3-7%	200 feet
8-10%	100 feet

In addition, the disturbed area of the entire road prism on sections designated by the Forest Service shall be rehabilitated as directed by the Forest Service.

SPECIFICATION 10 - PRELIMINARY SURVEY (PERMANENT ROADS)

1.1 This specification covers the work to be performed to obtain a "P" line survey which shall consist of a surveyed centerline, referenced upon the ground, together with all horizontal and vertical control data necessary for subsequent use in design and final location of a road. All alignment, profile, and cross section data shall be recorded in fieldbooks of acceptable form and manufacture. The survey shall be performed under the direction of a competent engineer.

1.2 The general route to be followed shall be approved on the ground by the Forest Service before surveying begins.

1.3 All methods, equipment, and materials used to accomplish the required precision under this specification shall be of a quality ordinarily used in the engineering profession for road survey. The absence, omission, or failure to include in this specification items which are normally considered to be a part of engineering procedure and utilization of engineer's judgment shall not be used as a basis for submission of inadequate work or incomplete engineering performance.

Survey Methods

2.1 The horizontal traverse, level traverses, and cross sectioning performed under this specification shall meet the minimum requirements of Exhibit I, Precisions A, B, or C as defined in Clause B5.0 Specified Road Construction Specifications.

2.11 Evidence of verification that horizontal and level traverse processes contain no gross errors shall be presented in the form of field notes or other data that can be readily checked for accuracy.

Angular measurements shall be verified by one or a combination of the following methods:

- a. Astronomic observations
- b. Triangulation configurations
- c. Procedural checks, approved by the Forest Service

Traverse distances between angle or control points shall be verified by check measurements to an accuracy of 0.5 percent.

A level traverse shall be made through and closed on each project bench mark.

2.12 Cross sections shall be taken along lines projected within 1 degree of a true perpendicular to tangents and a true bisector of angle points.

All measurements shall be recorded to the nearest 0.1 foot in horizontal and vertical distance or to the nearest 0.2 foot of slope distance and nearest percent of slope.

Where ground slope appears uniform, cross section measurements shall be recorded at 50-foot maximum intervals along the cross section.

2.2 The traverse shall not deviate more than 50 feet from the marked general route except as required to comply with deflection angle and intervening tangent requirements below. The course of the beginning tangent of the traverse shall be determined by astronomic observation, or an alternate method approved by the Forest Service. A hub and tack will be set at each traverse angle point and identified by a guard stake.

Stakes shall be solidly set in the ground along the traverse line at intervals not in excess of 70 feet and, where practicable, shall be set at station and half-station points. Each ground break, as described below, shall be staked. A ground break shall be considered to be a change in ground slope of 2 degrees.

Deflection angles between tangents shall not exceed 30 degrees with connecting tangent lengths of not less than 60 feet.

Stakes established on tangents between angle points shall be set within 0.1 foot of the measured distance for the stake. For purpose of this specification, a station shall be 100 feet.

2.21 Perpetuation of the traverse line--two adjacent traverse angle points at approximate 1,000-foot intervals along the traverse line shall be referenced as shown in Exhibit II.

2.3 Temporary bench marks shall be set at approximate 1,000-foot intervals along the "P" line outside the traveled way, and be identified by number and elevation. The mark shall be a 40-penny or larger nail driven vertically into a notched tree root or other permanent, easily identified object. If the bench mark is set in a tree root, the notch will be no higher than 18 inches from the ground and cut to allow a rod at least 13 feet long to stand vertically and squarely on the mark. Alternate bench mark construction may be used if approved by the Forest Service.

Ground elevations shall be taken to the nearest 0.1 foot at each point established on the traverse line. Where the centerline level traverse is run independently of the bench mark levels, the level traverse shall close on the bench marks within the limits of the precisions specified.

2.4 Cross section shall be taken at every point staked on the traverse. Additional sections shall be taken along all drainage channels, with an angular tie to the traverse, or bearing of the channel section recorded. The cross section shall extend not less than 100 feet horizontally each side of the centerline unless otherwise agreed. Existing features such as streams, buildings, fences, roads, rock bluffs, etc., within or adjacent to the cross sections shall be recorded.

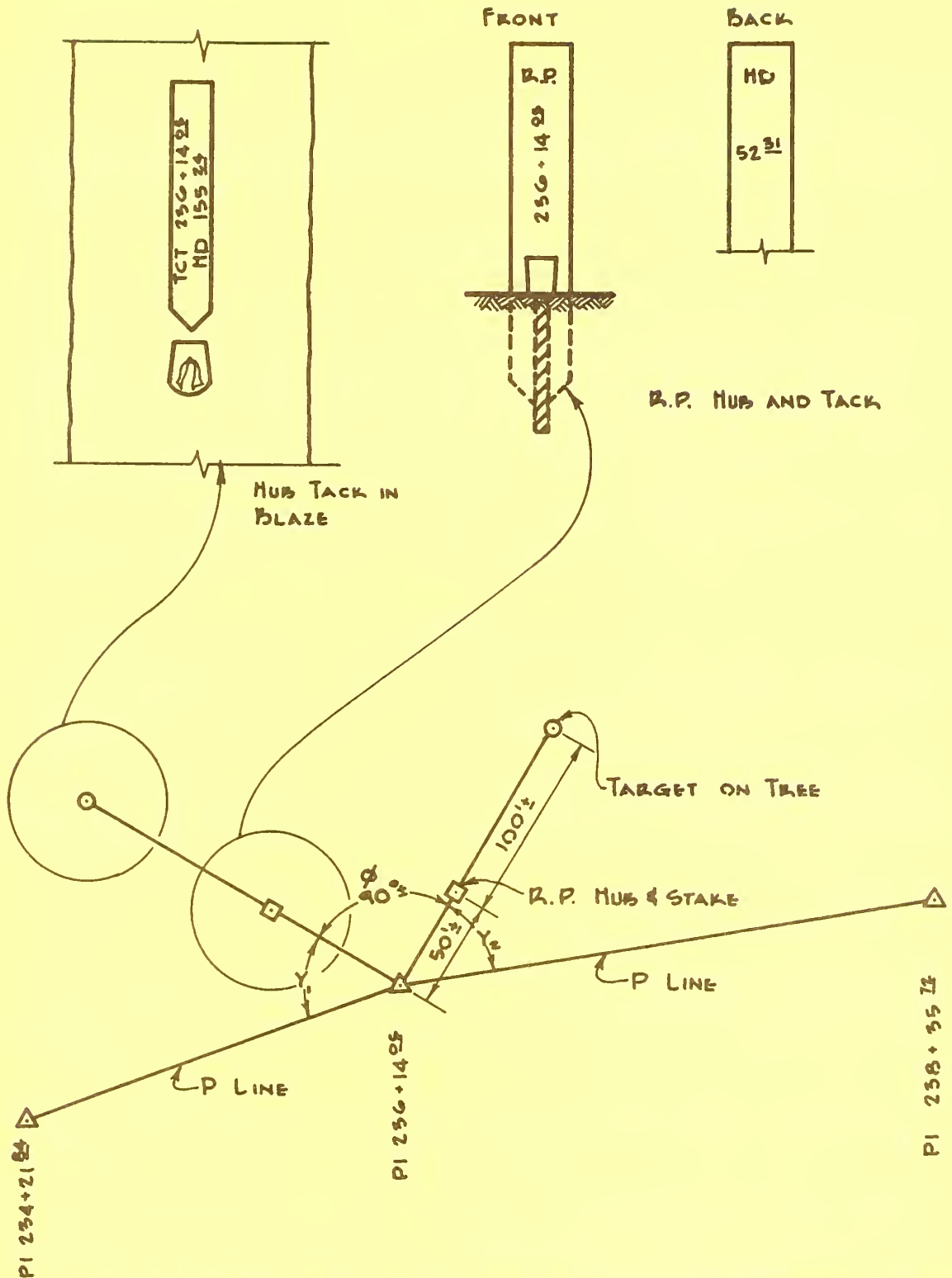
2.5 Soil and cover classification data shall be obtained after the "P" line with recommended cut and fill slope ratios. Clearing cover type shall be listed by engineering stations and shall be recorded as: (1) open, (2) light, (3) heavy, (4) mixed brush and light timber, and (5) timber, medium to heavy. The soil and ground cover notes shall also include an estimate of runoff factors, as used in the rational method for calculating design discharge, for each drainage area the line crosses.

2.6 All stakes shall be furnished by the operator. Hubs shall be nominal 2" x 2" x 12". Stakes and guard stakes shall be nominal 3/4" x 1 1/2" x 18". Lath may be used for identification stakes.

EXHIBIT I

SURVEY PRECISION	TRAVERSE					CROSS SECTION ACCURACY REQUIRED		
	HORIZONTAL AND VERTICAL ACCURACY REQUIRED		TRAVERSE			Horizontal & Vertical		Variation of Ground Surface Recorded
	Angular Error of Closure At Azimuth Check Points	1/ Azimuth Check Points Not to Exceed	Number of Azimuth Courses Between Azimuth Check Points	Distance Between Control Pts. Accurate Within	Vertical Error of Closure Bench Marks	Tolerance as Percent of Horizontal Distance	Slope	
Class	Allowable Survey Error						0 to 60% + 60% +	
A	1/5,000	30 sec. \sqrt{N} or 8 sec. per azimuth station	50	1/7,500	0.1' \sqrt{M} or 0.0025' per sta. in loop	\pm 0.5	\pm 1.0	0.5 ft.
B	1/3,000	1'0" \sqrt{N} or 15 sec. per azimuth sta.	160	1/4,000	0.25' \sqrt{M} or 0.01' per sta. in loop	\pm 0.5	\pm 1.0	0.5 in.
C	1/1,000	1'30" \sqrt{N} or 20 sec. per azimuth sta.	260	1/2,000	1.0' \sqrt{M} or 0.04' per sta. in loop	\pm 1.0	\pm 2.0	1.0 in.
D	1/600	May deviate from magnetic bearing 10 min. per mile		1/700	4.0' \sqrt{M} or 0.1' per sta. in loop	\pm 1.0	\pm 2.0	1.0 in.
E	1/300	If forward and backward bearings of tangents differ by more than $\frac{1}{2}$ degree, bearings must be computed as deflection angle traverse		1/350	8.0' \sqrt{M} or 0.2' per sta. in loop	\pm 1.0	\pm 2.0	1.0 in.
1/ Use least value					N = Number of azimuth stations		M = Number of miles in level loop.	

EXHIBIT II



1. Angle θ between sight lines to be as near 90° as practicable and recorded to nearest 30 sec.
2. Angle Y or Y_2 to be recorded to nearest 30 sec.
3. Stationing of traverse point referenced and control point used for sighting to be noted.

SPECIFICATION 11 - LOCATION SURVEY AND CONSTRUCTION STAKING (PERMANENT ROADS)

Description

1.1 This specification covers the work to be performed to obtain a transit "L" line survey which shall consist of a surveyed centerline, referenced upon the ground, together with all horizontal and vertical control data necessary for subsequent use in design and earthwork balancing under Specification 13. All alignment, profile, and cross section data shall be recorded in fieldbooks of acceptable form and manufacture. The survey shall be performed under the direction of a competent engineer.

1.2 The general route to be followed shall be approved on the ground by the Forest Service before surveying begins.

Materials

2.1 Stakes. All stakes shall be furnished by the operator. Hubs shall be a minimum of 2" x 2" x 12". Guard stakes and other stakes shall be 1" x 2" x 18". Lath may be used for identification stakes.

2.2 Fieldbooks. Bound engineering fieldbooks for recording centerline alignment notes, cross section notes, and slope stake notes shall be furnished by the operator. Fieldbooks to be supplied shall be standard hard cover.

Staking

3.1 Survey Precision. A table of accuracy requirements for traverse and levels is contained in Exhibit I. The "L" line, including level circuit survey, shall meet the requirements of the precision stated on Drawings as listed in Exhibit II.

3.2 Alignment. The horizontal alignment shall consist of a series of true circular curves and connecting tangents. Every effort shall be made to harmoniously fit the design to the terrain.

3.3 Establishing "L" Line. Operator shall establish "L" PI's on the ground as determined by terrain. Points established in this phase of the work shall be used only to determine the direction of tangents.

The deflection angles from one tangent to another shall be measured and the corresponding curve calculated. The PT and PC shall then be established.

After establishment of control points, stationing shall be established continuously throughout the project. Equations shall be introduced at the PT of curves where necessary. Centerline stakes shall normally be set at each station and all obvious breaks in the ground, except in no case shall stakes be more than 70 feet apart. For curves of 20 degrees or more with lengths over 100 feet, stake every 25 feet. All other curves shall be staked every 50 feet.

Stakes shall be set within 0.1 foot of the measured distance for that point.

Stakes shall be driven on the centerline with the station marked on the side facing the initial station of the project. (See Exhibit IV.) In order to easily identify the construction centerline, the letters shall precede the station number or the stake tops shall be dipped in a bright red- or orange-colored dye or paint. Where centerline stations fall in the existing roadway, stakes shall be offset distance right or left from centerline marked on the side of the stake facing centerline. Nails (8d or larger) or other suitable markers shall be driven on the centerline to denote the actual centerline point.

The survey line, where necessary, shall be cleared in such a manner as to facilitate ease of travel and surveying. Any clearing slash shall be removed from the travel or work area. All brush and trees less than 4 inches in diameter shall be square cut as near the ground as possible without damaging cutting tools. Stumps less than 8 inches in diameter shall be square cut not over 6 inches high. Windfalls may be cut from the line to facilitate ease of travel.

3.4 Vertical Control. Bench marks shall be set at approximately 1,000-foot intervals along the "L" line outside the traveled way, and be identified by number and elevation. The marks shall be a 40-penny or larger nail driven vertically into a notched tree root or other permanent, easily identified object. Alternate bench mark construction may be used if approved by the Forest Service.

Ground elevations shall be taken to the nearest 0.1 foot at each point established on the "L" line. Where the centerline level traverse is run independently of the bench mark levels, the level traverse shall close on the bench marks within the limits of the precisions specified.

3.5 Cross Sections. Cross sections shall be taken at every point staked on the "L" line. Additional sections shall be taken along all drainage channels, with an angular tie to the "L" line. The cross section shall extend not less than 100 feet horizontally each side of the centerline unless otherwise agreed. Existing features such as streams, buildings, fences, roads, rock bluffs, etc., within or adjacent to the cross sections shall be recorded.

3.6 Soil and Cover Classification. Soil and cover classification data shall be obtained after the "L" line stationing is staked. Surface soil types shall be listed by stations along the "L" line with recommended cuts and fill slope ratios. Clearing cover type shall be listed by stations and shall be recorded as: (1) open, (2) light, (3) heavy, (4) mixed brush and light timber, and (5) timber, medium to heavy. The soil and ground cover notes shall also include an estimate of runoff factors, as used in the rational method for calculating design discharge for each drainage area the line crosses.

3.7 Slope Staking. Prior to slope staking, operator shall prepare a grade book. The grade book shall indicate the ground elevation at centerline, road grade elevation at centerline, distances from centerline to shoulders (including widening), elevation of each shoulder, horizontal width of ditch, transition, and superelevation and crown (when applicable). The grade book shall be made in the format of Exhibit III.

Computations shall be made and booked for all stations that are to be slope staked or cross sectioned.

Operator shall compare the found centerline cut and fill depth with Drawings. Differences exceeding 1 foot at any one station shall be reported to the Forest Service for determination of need for revision.

3.8 Referencing "L" Line. The "L" line shall be referenced so that it can be reestablished at any time. Each control point except initial and final points shall be visible from one or more control points on the centerline. Points normally referenced shall be the PI or PC and PT of all curves. POT or POC points shall be referenced if necessary to maintain intervisibility.

Reference shall consist of tacked hubs with guard stakes and targets, set beyond the clearing limits to avoid disturbance during construction. The hubs shall be set so that the control point may be reestablished by the intersection method. The angle of intersection between the lines from the reference hubs should be as near 90 degrees as practicable. The distance between the hub and target shall not be less than 35 percent of the distance between hub and referenced point. (See Exhibit V.)

Reference hubs and targets shall be identified by markings on the guard stake identifying the control point referenced.

3.9 Slope Stake Referencing, Slope Stakes, and Clearing Limits. Operator may use engineer's level, hand level, slope board, Rhodes arc, Abney level, or transit to perform these operations within the precision requirements of this specification. Stakes and cross sections under this section shall be established on each side of the centerline, at each center-

line stake set under the provisions of Paragraph 3.3. These sections and stakes shall be set on a true perpendicular to the centerline tangents and on true radial lines on curves. Cross sections shall be cleared only to the extent necessary so that stakes are visible by projection from the centerline.

Slope stakes shall be established on each side of the centerline. Operator shall mark the slope stakes and centerline stakes as shown in Exhibit IV.

Resetting Slope Stakes. After clearing and grubbing is completed and before excavation in any area is started, slope stakes shall be reset.

Slope reference stakes for each slope stake shall be set a minimum distance of 10 feet outside the clearing limits. These references serve as secondary horizontal control and shall be marked as shown in Exhibit IV.

When precision A or B is specified, an elevation peg shall be driven flush with the ground at each reference point and all vertical measurements shall be referred to this peg. Levels shall be run over the pegs between bench marks with a permissible closure error on the bench mark of 0.1 foot. If the elevation of the peg is more than 0.1 foot different from the elevation determined by slope staking, the reference stake, peg, and slope stake shall be reset to the correct precision. Datum elevations shall be marked on the reference stake for each peg.

When precision C or D is specified, the ground elevation at each slope stake shall be compared with the ground elevation at the preceding slope stake. If the difference as referred to datum is found to vary more than 0.3 foot, the section shall be rerun and the stakes placed in their correct location.

Cross sections shall be measured as required by the precision established in 3.5 of this specification. Catch points shall be recorded in the notes as ground points. Slope stakes, slope reference stakes, cross section and clearing limit information shall be recorded in bound fieldbooks in the form illustrated in Exhibit III.

Clearing limits are to be visibly marked by operator with yellow ribbon flagging on trees or brush to be left standing. Clearing markers shall be intervisible, but in no case further than 100 feet apart. Each ribbon shall be set at least 3 feet above the ground surface and shall have a tail at least 18 inches long. Clearing limits shall be established on both sides of the project centerline by direct horizontal measurement from the slope stake catch points. Distances to the clearing limits shall be determined as shown on the typical sections.

3.10 Staking Structures. All culverts shall be staked with hubs driven on the centerline of the culverts approximately 10 feet from each end. In addition, a guard stake shall be set at each hub and the guard stake shall have the following information marked on it:

- a. Diameter, length, and type of culvert (such as, 18" x 36' CMP).
- b. The amount of cut or fill from the hub to the invert at the end of the culvert.
- c. The horizontal distance from the hub to the end of the culvert.
- d. Flow line grade of the pipe.

Headwalls for culverts, where required shall be staked by setting a hub with a guard stake on each side of the culvert on line with the face of the headwall.

3.11 Field Notes. All notes shall be recorded in bound engineering fieldbooks. Notes shall conform to formats contained in this specification and shall be clean and legible. Errors shall be deleted by lining out. All notes, including the originals, shall become the property of the Forest Service.

3.12 Stake Replacement. Stakes found to be erroneously set or stakes lost, destroyed, or damaged shall be reset within 24 hours after notification, when practicable, to the precision required by this contract.

3.13 Stake Approval. No construction work shall begin within a section of the project until the Forest Service approves in writing the stakes, marks, or controls established by operator for the construction work within that section.

EXHIBIT I

Survey Precision	ACCURACY REQUIRED			
	Linear Error of Closure	Angular Error of 1/ Closure At Azimuth Check Points	Number of Azimuth Courses Between Azimuth Check Points Not to Exceed	Distance Measurements Accurate Within
A	1/5,000	30 sec. N or 8 sec. per azimuth	50	1/7,500
B	1/3,000	1/0" N or 15 sec. per azimuth sta.	160	1/4,000
C	1/1,000	1'30" N or 20 sec. per azimuth sta.	260	1/2,000
D	1/600	May deviate from magnetic bearing 10 min. per mile		1/700
1/	Use least value	N = Number of azimuth stations	M = Number of miles in level loop	

Vertical 1/ Error of Closure On Bench Marks

0.1' M or 0.0025' per sta. in loop

0.25' M or 0.0025' per sta. in loop

0.5' M or 0.01' per sta. in loop

0.5' M or 0.1' per sta. in loop

EXHIBIT II
CROSS SECTION AND SLOPE STAKE PRECISION

	Precision			
	A	B	C	D
Cross section topography - Points shall be taken so that variations in ground from a straight line con- necting cross section points will not exceed	0.3 ft.	0.3 ft.	0.5 ft.	0.5 ft.
Horizontal and Vertical Accuracy, as percent of distance measured				
A. Slope Stakes	+0.25%	0.5%	0.5%	1.0%
B. Slope Reference Stakes	+0.25%	0.5%	0.5%	1.0%
Slope reference hubs or Guinea	Req'd Verify by level run	Req'd Verify by level run	Not req'd Verify slope stake by com- parison to pre- ceding slope stake	Not req'd



"STAKED"

CLEARING

<u>L</u>	<u>R</u>
352	252

SPECIFICATION 13 - DESIGN (PERMANENT ROADS)

Description

1.1 The operator shall provide complete drawings, applicable construction specifications, construction cost estimate, and shall prepare a complete set of fieldbooks for staking the project in accordance with the design.

Design

2.1 General. Design shall be accomplished under the direction of a registered engineer unless otherwise agreed.

2.2 Alignment. The horizontal alignment shall consist of a series of true circular curves and connecting tangents. Every effort shall be made to harmoniously fit the design to the terrain.

Vertical curves on two lane roads shall be designed to provide a stopping sight distance not less than that required for the design speed. Vertical curves on single lane roads should be designed to provide a stopping sight distance not less than twice that required for the design speed. In general, vertical and horizontal curves should not be coincidental. Exceptions will be made when the sight distance meets the design requirements and where a material savings in cost can be effected. When feasible, apex sags should not be located on through fills, except when cross drainage is relieved by means of a berm and drainage structure.

Horizontal and vertical curves on single lane roads shall be designed for two lanes when the stopping sight distance is less than twice the length required for the design speed. For double lane curves, the taper shall start at the PC and end at the PT, provided a minimum length of 100 feet and a travelway of 24 feet in width is obtained.

Turnouts shall be intervisible or spaced not more than 1,000 feet apart. Turnouts shall be 10 feet in width for 100 feet with 50-foot tapers on each end. Two lane curves on single lane roads shall be considered as turnouts.

2.3 Earthwork. Cut slopes will be dependent upon the material involved, the height of cut, and the natural slope of the ground. Grade-lines shall be established to achieve economical design with regard to earthwork quantities. Forest Service shall be consulted concerning locations of possible borrow or waste areas and volume adjustment factor. Sudden pitched grades and long sustained maximum grades should be avoided.

The total quantity of excavation shall be broken down into the following:

Cubic yards of waste side cast material.

Cubic yards of material moved within the freehaul distance.

Cubic yards of material moved more than the freehaul distance.

Cubic yards of rippable and cubic yards of blasting rock.

Cubic yards of surfacing and base course material when required.

2.4 Drainage. Culvert size and location shall be determined from ground profile, drainage areas, rainfall data and, where possible, from high water measurements. Forest Service shall be consulted regarding rainfall data, streamflow, and culvert design practice.

Culverts shall be placed in natural channels with outlets flow line at channel grade except where a material saving in construction costs can be effected by skewing the pipes so that outlet will spill on solid rock or other nonerosible material. Minimum diameter culverts permissible is 18 inches. All culverts shall be shown on the plan and profile portion of Drawings.

2.5 Drawings. A detailed quantity estimate list shall be shown on Drawings. It shall include a separate item for each category of work necessary to complete the road construction.

A mass diagram shall be prepared and made part of Plans at a scale of 1 inch equals 100 feet horizontal and 1 inch equals 2,000 cubic yards vertical, or 1 inch equals 5,000 cubic yards vertical if required for a better representation. The final balance points, the excavation, embankment and overhaul quantities, and the direction of haul shall be shown. Freehaul distance shall be 1,000 feet.

Drawings shall be furnished including a completed set of final plan and profile tracings, typical sections, quantity list, drainage sheet, etc., all prepared in accordance with standard highway engineering practices. The tracings shall be on standard Federal Aid 23" x 36" plan profile sheets on which shall be shown the final located centerline and existing "P" line with engineer's stations, alignment data, the location of culverts and bridges, bench marks to be moved when it is determined they are within the clearing limits, landownership and property boundary lines and a north arrow. The scale shall be 1 inch equals 100 feet.

The profile portion of Drawings shall show the final location of the "L" line ground profile, gradelines, vertical curves, location and size of culverts, other drainage structures, and bridges. Also shown shall be balance points with excavation, embankment and overhaul between balance points, location of turnouts, two lane sections, and roadway dikes. The vertical scale shall be 1 inch equals 10 feet unless otherwise listed in Specifications List.

All symbols, lines, letters, and numbers shall be of such size and weight as to be clear and legible when the finished sheets are reduced to one-half original size. Tracings may be in pencil.

On the typical section sheet shall be shown an estimate of quantities including acres to be cleared, cubic yards excavation, station yards overhaul, total lineal feet of culverts by diameter size, number of drop inlets, and other construction items. The items on these sheets may be typed.

Representative samples of the various tracings and detailed Drawings of standard construction items used on Forest Service roads are available from the Forest Service.

Forest Service shall review the design and Drawings prior to completion of the design to determine their compliance with the specifications. Adjustments shall be made as recommended by the Forest Service.

SPECIFICATION 16 - CONSTRUCTION STAKING

Description

1.1 This item shall consist of complete engineering services for the construction staking of the project by the P-Offset method in accordance with Drawings and these specifications. Included is the furnishing of all labor, equipment, and materials, Construction staking shall be accomplished under the direction of a competent engineer.

2.1 Stakes. All stakes shall be furnished by the operator. Hubs shall be a minimum of 2" x 2" x 12". Guard stakes and other stakes shall be 1" x 2" x 18". Lath may be used for identification stakes.

3.1 Centerline ("L" line) shall be established by measuring on the ground a distance right or left from "P" line as shown on a "listing of offsets" approved by the Forest Service. The "L" line thus established shall be adjusted only to correct misalignment created by measured offsets along severely skewed sections.

3.2 Slope stakes shall be established on each station shown on the "listing of offsets". The position of these stakes shall be established by determination of grade elevation of each station as shown on Drawings compared to the ground at each station and applied to typical or special sections shown on Drawings.

3.3 Clearing limits shall be established by a measured distance beyond the slope stakes as shown on the typical section.

3.4 Reference stakes shall be set at or outside of the clearing limits at established stations not to exceed 100 feet apart. Reference stakes shall be marked as RP and show horizontal distance to centerline of road and vertical distance to grade of road measured from the ground at the reference stake.

3.5 Culvert installations shall be designated on the ground by offset stakes established at the clearing line, which show horizontal distance to each end of the culvert and vertical distance to the invert of the culvert measured from the ground at the offset stake.

3.6 All measurements shall be to an accuracy of:

a. Establishment of "L" line from "P" line to within 1.0 percent of measurement shown on the furnished listing.

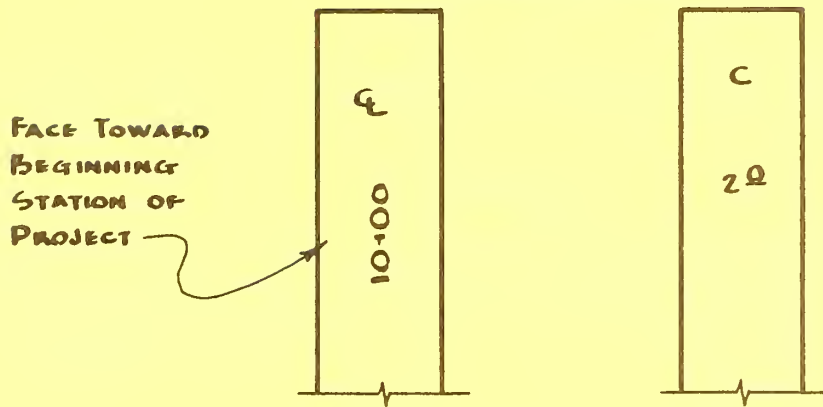
b. From such established "L" line, the location of reference and slope stakes (horizontal) and (vertical) to within 2.0 percent the lines and grades shown on Drawings.

c. Location of clearing limits shall be within 1 percent of the distance shown on Drawings.

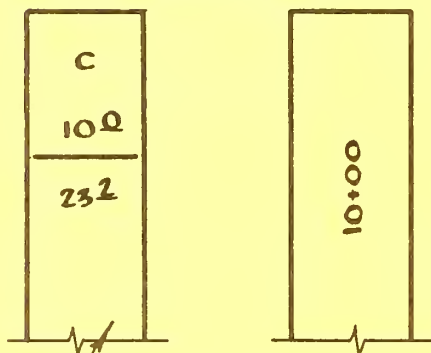
3.7 All stakes shall be marked as shown on Exhibit I.

CONSTRUCTION STAKES

CENTERLINE STAKES

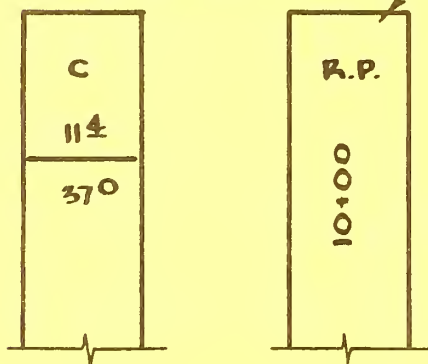


CUT SLOPE STAKE

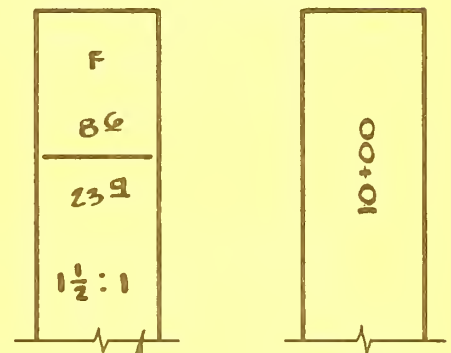


FACE TOWARD
CENTERLINE

REFERENCE STAKE

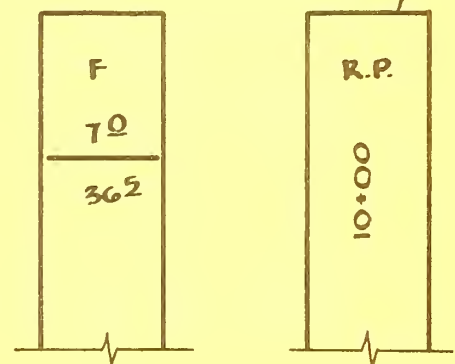


FILL SLOPE STAKE



FACE TOWARD
CENTERLINE

REFERENCE STAKE



SPECIFICATION 22 - CLEARING, GRUBBING, AND SLASH CLEANUP

Description

1.1 This work shall consist of clearing, grubbing, removal, and disposal or treatment of timber, construction slash, and noncombustible debris within the areas designated on the ground, shown on Drawings, unless agreed otherwise.

Construction Requirements

3.1 Clearing. Clearing shall consist of removal of all trees, snags, and timber, brush, and other vegetative and noncombustible debris within roadway and disposal of construction slash from within clearing limits. Inside clearing limits but outside of roadway, trees up to 6 inches dbh need not be cut if they will not interfere with visibility or slope stability. In any case, brush and trees in the same area less than 3 feet in height and less than 3 inches in diameter that do not interfere with visibility shall be left when feasible.

3.2 Grubbing

a. Within roadway, all stumps, roots, and other wood larger than 3 inches in diameter shall be grubbed, except that undisturbed stumps in embankment areas may be left in place if they do not extend closer than 2 feet to any subgrade or slope surface, and do not interfere with placement or compaction of embankment as specified under roadway excavation. Within excavation areas of roadbed, all roots over 3 inches in diameter shall be grubbed to a minimum depth of 12 inches below subgrade, except in rock where this is not feasible. Roots protruding from cut slopes shall be cut as near flush with the cut slope surface as practicable.

b. Within clearing limits, but beyond roadway, stumps may be left in place, but shall be cut as low as practicable at the time of felling of trees. Remaining stubs and slivers shall be trimmed from stumps.

c. Objects obtruding upon or obstructing the use and maintenance of the road shall be removed.

3.3 Slash Cleanup Methods

a. All methods. Construction slash more than 3 inches in diameter and 3 feet long, and concentrations of construction slash which would

adversely affect the stability of the completed road shall be disposed of. Disposal of construction slash shall be by one or more of the following methods: removing, burying, chipping, and piling and burning.

Construction slash and noncombustible debris shall not be placed in lakes or meadows, streams, or streambeds where they might be moved by or obstruct the flow of water, and shall be removed if unavoidably placed therein.

b. Special methods. Disposal shall conform to the following requirements for methods or methods used.

1. Removing. Construction slash shall be moved or hauled to designated locations shown on Drawings and designated on the ground where it shall be piled and burned, or buried, in accordance with the requirements herein for piling and burning, or burying.

2. Burying. Construction slash shall be buried where agreed in borrow areas, pits, trenches, or other locations outside roadway, but reasonably near the area of origin. Construction slash shall be matted down in layers and covered with at least 2 feet of rock and soil so that the final surface is sloped to drain and is relatively smooth.

3. Chipping. Chippable construction slash, 3 feet or more in length and up to at least 4 inches in diameter, shall be processed through a chipping machine, and chips shall be deposited on fill slopes or outside roadway to a loose depth not exceeding 6 inches. Chips may be permitted within roadway, if they are thoroughly mixed with rock or soil and do not form a layer.

4. Piling and burning. Construction slash shall be piled and burned within clearing limits or other approved areas. Piles shall be constructed of such size and at such distance from trees so that burning shall not result in unnecessary damage to trees. In the event burning is incomplete and concentrations of slash remain, such slash shall be treated as residual construction slash.

c. Residual construction slash. Residual construction slash shall be buried.

d. Noncombustible debris. Noncombustible debris shall be buried or removed to agreed locations.

3.4 Pioneer Roads. The location and construction of pioneer roads shall be such as to not adversely affect the completed specified road. Pioneer road shall be inside clearing limits unless otherwise agreed.

SPECIFICATION 31 - ROADWAY EXCAVATION FOR PERMANENT ROADS

Description

1.1 This work shall consist of excavating and shaping roadway and related work shown on Drawings or designated on the ground. It will also include excavating and disposing of unsuitable materials; excavating suitable materials from roadway or borrow pits and placing suitable materials in embankment or backfills; and placing of excess excavated materials. Work shall be in accordance with specifications in reasonable conformity with the lines, grades, and dimensions shown on Drawings. By agreement minor field adjustments may be made to balance quantities or to meet other field problems.

Construction Materials

2.1 Excavated Materials. All excavation shall be considered unclassified regardless of the nature of the material excavated.

2.2 Borrow. When borrow is designated on Drawings, it shall consist of the excavation of suitable material from sources shown on Drawings, or a supplemental map attached thereto.

Operator shall notify the Forest Service sufficiently in advance of need for borrow material not shown on Drawings or a supplemental map attached thereto so that use of such material can be approved in advance.

Construction Requirements

3.1 Excavation and Placement. Suitable excavated material shall be used without unnecessary waste in the formation of embankment, subgrades, shoulders, slopes, bedding, and backfill for drainage structures and for such other uses as shown on Drawings or staked on the ground, unless otherwise agreed. Excavation and placement of materials shall be conducted so that unsuitable debris will not be incorporated in roadway. Reasonable precautions shall be taken during construction to avoid damage to structures. During construction the work shall be conducted to provide adequate drainage and minimize soil erosion.

3.2 Disposal of Excess Excavation. Designed excess excavation shall be disposed of as shown on Drawings. When agreed, unanticipated excess excavation shall be reduced or eliminated by changes in grade or alignments,

or disposed of by uniformly widening embankments, by flattening embankment slopes, or by depositing in agreed locations. Such locations of potential disposal areas not shown on Drawings shall be agreed to in advance of need and designated on the ground in such locations that land and resource values will not be adversely affected.

3.3 Rock for Slope Protection. By agreement, excavated rock suitable for protection of embankments adjacent to streams or for protection against slope or channel erosion as shown on Drawings shall be conserved and used in lieu of designated materials source.

3.4 Conserving Material. Where shown on Drawings, or by agreement, during the progress of excavation, material suitable for cushion or other purpose shall be saved and utilized. Such material may be used in lieu of materials from designated source. Excessively wet material which is otherwise suitable for embankment will be field drained and dried for placement.

3.5 Unsuitable Excavation. Swamp or marsh excavation and other unuseable excavation shall be excavated as necessary and deposited as shown on Drawings or agreed location. The excavated areas shall be backfilled with suitable materials unless otherwise shown on Drawings. Frozen materials shall not be placed in embankment. Unless otherwise shown on Drawings, rock or boulders encountered during construction, which are too large to be incorporated in adjacent embankment, shall be broken as necessary and incorporated in embankment; or maneuvered to the face of embankment and embedded so they will not roll; or moved to agreed location.

3.6 Ditches. Ditches shall include roadway ditches, channel changes, inlet and outlet ditches for culverts, and ditches parallel to the roadway but beyond roadway limits. Ditches shall be constructed as shown on Drawings, or as staked on the ground. Where excavation is in excess and would adversely affect drainage, such places shall be corrected. Roots, stumps, and other foreign material shall be removed from ditches.

3.7 Snow Removal. If operator desires to work when the site is covered with snow sufficiently deep to impair the quality of work, operator shall remove the snow in advance of the work and deposit it beyond the limits of the work in a manner that will prevent land and resource damage.

3.8 Finishing Slopes. Slopes shall be constructed in reasonable conformity with lines staked on the ground or as shown on Drawings. The degree of finish for grading of slopes shall be that ordinarily obtainable with normal road construction equipment. If shown on Drawings, the finished slope shall have ridges or otherwise be roughened to facilitate the establishment of vegetative growth.

3.9 Preparing Ground Surface for Embankment. If necessary to provide permanent bonding of the new and old materials on steep side slopes, surfaces upon which embankment is to be placed shall be roughened or stepped.

3.10 Placing Embankment. Operator shall take reasonable precautions to prevent excavated material from escaping beyond embankment toe. Suitable excavation shall be place in layers no more than 12 inches thick, except if excavated rock is more than 8 inches in diameter, the layers may be of sufficient thickness to accommodate the material involved, but no layer shall exceed 24 inches before compaction.

All embankment shall be layer placed except over rock surfaces where material may be placed by end dumping to a minimum depth needed for operation of spreading equipment. Each embankment layer shall be approximately leveled and smoothed prior to placement of subsequent material. Hauling and spreading equipment shall be operated over the full width of each layer.

Rocks or boulders, provided the embankment will accommodate them, may be placed in embankment. They shall be carefully distributed with the voids filled with finer material to form a dense and compact mass. When embankment is to be constructed across swampy ground and removal of material is not required, the lower part of the fill may be constructed in a single layer to the minimum depth necessary to support the hauling equipment.

Where material containing a large amount of rock is used to construct embankments, a solid fill with adequate compaction will be provided by working smaller pieces in with the larger rocks and fines to fill the remaining voids and by operating hauling and spreading equipment over the full width of each layer as the fill is constructed.

3.11 Finishing Roadbed. Unless otherwise agreed or shown on Drawings, the top 6 inches below finished roadbed surface of unsurfaced roads shall consist of cushion material relatively free of vegetative matter. Where cushion material contains rocks exceeding 4 inches in greatest dimension, the roadbed shall be scarified and such oversize rock brought to surface shall be removed. Where suitable cushion cannot be developed by scarifying, suitable material will be imported or developed from agreed sources for cushion. Roadbed shall be shaped to conform to Drawings.

SPECIFICATION 33 - BORROW FROM PITS AND QUARRIES

Description

1.1 This work shall consist of material to be used for borrow as designated on Drawings. The work also shall include pit or quarry stripping, stripping replacement, and cleanup.

1.2 Borrow pits on Government land needed for fill or surfacing material on the road covered by the road permit and lying outside of the right-of-way provided, will be covered by separate permit which will be approved by the District Ranger upon application by the operator.

Materials

2.1 General. The material shall be of the gradation and quality required for the intended use as shown on Drawings or in specifications.

2.2 Approval of Pits and Quarries. Borrow will be obtained from sources shown on Drawings or supplemental map attached thereto, or as otherwise agreed.

Other sources may be approved if gradation and quality tests of samples therefrom indicate that the produced material will be suitable for intended use.

If operator elects to obtain material from sources other than on National Forest land, operator shall be responsible for taking samples and obtaining tests for acceptable quality, and for the right to use the material, including any cost or royalty involved.

Construction Requirements

3.1 Borrow Pits. Borrow pits, except when specifically permitted to the contrary, must not be visible from the completed road unless they are contiguous to and in effect a part of the road prism. Where practicable, borrow pits shall be so excavated that no water will collect or stand in them. Continuous borrow pits are to be provided with cross dams and contour diversion ditches to reduce volume and velocity of surface runoff during peak flow periods. Banks of borrow pits shall be shaped to 3:1 or flatter slope before seeding.

3.2 Clearing, Grubbing, and Slash Cleanup. Clearing and grubbing of pits and quarries and access roads thereto shall be accomplished prior to the beginning of excavation in accordance with the specification applicable to the nearest specified road segment unless otherwise agreed.

3.3 Stripping and Stockpiling Topsoil. Topsoil, overburden or spoils material shall be stripped and stockpiled prior to excavation of borrow material as shown on Drawings or as otherwise agreed.

Stockpile sites shall be cleared and leveled prior to use and shall occupy as small an area as reasonably possible.

3.4 Excavation and Cleanup. Unless otherwise agreed, pits or quarries shall be excavated so that water will not collect in them, and after the borrow excavation has been completed, the sides shall be sloped and the general pit area and the haul road smoothed up. Cleanup will include roughly spreading the overlying material and topsoil back over the bottom and side slope areas suitable for reseeding, unless otherwise agreed.

SPECIFICATION 35 - BERM

Description

1.1 This work shall consist of the construction of a berm along the shoulder of traveled way conforming with the typical section and at the locations shown on Drawings.

Materials

2.1 The material used in the construction of berm shall be sufficiently well graded to allow or accept compaction for controlling water flow.

Construction Requirements

3.1 The material for berm may be worked up or derived from existing roadbed or traveled way if the material is satisfactory. When the existing material is not satisfactory, it shall be imported from an agreed source.

3.2 Compaction. Berm material shall be moistened or dried as necessary and then compacted.

SPECIFICATION 36 - RESHAPE AND FINISH EXISTING ROADWAY

Description

1.1 This work shall consist of restoring the roadway, such as removing slides, cleaning ditches, restoring previously installed drainage, scarifying, and reshaping the roadway in accordance with these specifications and as shown on Drawings or staked on the ground.

Construction Requirements

3.1 Conditioning Existing Roadway. Existing roadbed shall be scarified where needed for the full width and to a depth sufficient to eliminate surface irregularities. Scarified roadbed shall then be bladed, shaped, and placed to restore the surface to typical cross sections to provide a reasonably smooth traveled way. All deleterious material and stones over 4 inches in greatest dimension encountered during the operation shall be removed. Materials so removed shall not be left on shoulders or in ditches. Slide material shall be removed and used, if suitable, or disposed of as shown on Drawings or as agreed. All ditches and drains shall be reshaped and cleaned where necessary to insure efficient drainage. Backslopes shall not be undercut.

3.2 Additional Material. Additional material used to restore roadway to the required lines, grade, and cross section shall consist of suitable borrow, except where base course and/or surface course is required. Each of these materials shall be spread in a uniform layer, thoroughly mixed, placed, and shaped as outlined above.

3.3 Disposal of Surplus Material. Surplus material shall be disposed of at locations shown on Drawings by widening embankments, flattening slopes, or by depositing at agreed locations.

3.4 Rock Sections. Rock sections and other sections where the natural material is not suitable for cushion need not be scarified, but shall be brought to grade with a minimum cushion of suitable borrow and/or aggregate base course as shown on Drawings, and entire roadway shall be brought to the final elevation and shaped as shown on Drawings.

3.5 Damaged Structures. All work shall be done so as to avoid damage to existing drainage facilities, and any such damage resulting from construction operations shall be repaired by operator.

3.6 Finishing. Roadway shall be finish shaped to conform with the typical section shown on Drawings.

SPECIFICATION 37 - RIPRAP

Description

1.1 This work shall consist of furnishing and placing a protective or stabilizing covering of stone or other material in conformity with the materials descriptions, lines, and grades shown on Drawings and in accordance with these specifications or as otherwise agreed.

Materials (as shown on Drawings)

2.1 When stone riprap material is shown on Drawings, it shall be obtained from the source specified on Drawings or as otherwise agreed. Stone shall be of such quality that it will not disintegrate on exposure to water or weathering.

2.2 Loose Rock Riprap. Not more than 10 percent of the stones shall have a circumference of less than 18 inches when measured in the smallest section, and 50 percent, at least, of the stones shall have a volume of 2 cubic feet or more. Uniform gradation shall be maintained throughout the cross section of the riprap.

2.3 Heavy Loose Rock Riprap. Not more than 10 percent of the stones shall have a circumference of less than 24 inches when measured in the smallest section, and at least 60 percent of the stones shall have a volume of 8 cubic feet or more. Uniform gradation shall be maintained throughout the cross section of the riprap.

2.4 Loose Rock Fill. Not more than 10 percent of the stones shall have a circumference of less than 18 inches when measured in the smallest section, and at least 50 percent of the stones shall have a volume of 3 cubic feet or more. Uniform gradation shall be maintained throughout the cross section of the riprap.

2.5 Rock Embankment. The stones used shall be such that at least 50 percent of the individual stones shall have a volume of 3 cubic feet or more. No stone shall have a circumference of less than 19 inches when measured in the smallest section. Uniform gradation shall be maintained throughout the cross section of the riprap.

2.6 Derrick Placed Rock. Stones shall be placed individually using mechanical equipment such as a derrick capable of raising and lowering each piece into place. Not more than 10 percent of the stones shall have a circumference of less than 24 inches when measured in the smallest section, and at least 75 percent of the stones shall have a volume of 9 cubic feet or more.

2.7 Sacked Concrete. Sacked concrete riprap shall consist of concrete containing at least $3\frac{1}{2}$ sacks of cement per cubic yard, maximum aggregate size $2\frac{1}{2}$ inches and water content limited to that necessary to assure good workability without excessive seepage. Reasonably clean and strong aggregate of appropriate size gradation shall be used. Sacks shall be at least 10-ounce burlap or equivalent with capacity of approximately $1\frac{1}{2}$ cubic feet each. Sacks will be placed while contents are in moist condition.

2.8 Sacked Soil Cement. Sacked soil cement riprap may be composed of any combination of gravel, sand, silt, and clay with the following limitation. Top soil should not be used; 55 percent of the mixed soil shall pass the No. 4 sieve. The maximum size gravel shall pass the $1\frac{1}{2}$ -inch sieve. Sacks shall be at least 10-ounce burlap or equivalent with a capacity of $1\frac{1}{2}$ cubic feet each. The mixture should be moist and not have a soil lump over $\frac{1}{2}$ inch.

Sacks shall be placed while contents are in a moist condition. For guidance, the cement requirements in percent by volume for each soil group are shown below:

AASHTO Classification	Percent Cement
Soil Group	By Volume
A-1a	7
A-1b	9
A-2	10
A-3	12
A-4	12
A-5	13
A-6	14
A-7	15

Construction Requirements

3.1 Foundation. The slope of area upon which the riprap is to be placed shall be shaped to lines and grades shown on Drawings. The surface shall be roughened to provide a surface to which the base stones or other riprap material shall be keyed and firmly bedded. Foundation trenches shall be excavated at the toe of the slope or area to receive the riprap material to provide a secure footing. Slopes and foundation trenches shall be approved by the Forest Service before placing the riprap.

3.2 Placing Riprap. The riprap material shall be placed in reasonable conformity with lines and grades shown on Drawings and on the approved slope and in the foundation trench to form the specified cross section in a roughly regular surface without large cavities or excess projections above the general lines of the riprap layer. The surface of finished layers shall have the voids reasonably well filled.

SPECIFICATION 40 - CORRUGATED METAL CULVERT

Description

1.1 This work shall consist of furnishing as specified in materials list and installing, or installing only, corrugated metal culvert pipe or pipe-arches and connecting bands and metal end sections, of the types, thickness, sizes, and materials shown on Drawings or otherwise designated and in accordance with these specifications and in reasonable conformity with the lines and grades established. This work includes all excavation, bedding, and backfilling for culverts required to complete the structures as shown on Drawings.

Materials

2.1 Culvert shall be galvanized metal or aluminum alloy formed in a full circle, factory elongated if required, or a pipe-arch with lock seams, or lap joints fabricated by riveting, resistance spot welding, or continuous resistant butt-welded seams. All materials fabrication, workmanship, dimensions, and marking shall conform to Federal Specification WW-P-405a or WW-P-402c as current at the time of advertisement, or as otherwise provided in these specifications or in Drawings.

2.2 Coupling banks, end section, and other fittings shall conform to the requirements of the applicable Federal Specifications unless otherwise shown on Drawings, materials list, or as otherwise agreed. End sections shall conform to dimensions shown on Drawings.

2.3 The material used in each individual culvert installation shall be compatible to prevent electrolysis or physical failure.

Either annular or helical corrugations of pipe shall be acceptable, but each culvert installation shall consist of only one class of corrugation, unless otherwise agreed.

Construction Requirements

3.1 Handling. Culvert shall be handled in a manner to prevent damage to coatings. Breaks in coatings shall be repaired in accordance with manufacturer's recommendations. Culverts shall not have dents and distortions of cross section which reduce the dimensions between inside of crests at any point by more than 5 percent from nominal. Culvert walls shall not have any rupture or break.

3.2 Category I Culverts. Category I culverts are the following: Culverts with less than 10 feet of fill height at subgrade centerline, which are not in live streams (at the time of installation), and which are round culverts 42 inches in diameter or less, or which are pipe arches with spans 43 inches or less.

a. Excavation. When foundation is soft or otherwise unstable, such material shall be removed and replaced with suitable material to a depth which results in an adequate base for the culvert.

Where rock or other unyielding material is encountered and must be excavated, such material shall be removed below the foundation grade of the culvert for a minimum depth of 12 inches.

b. Bedding. Excavation below grade shall be backfilled with suitable material, lightly compacted to form a uniform but yielding foundation. Such material placed over rock or selected backfill in unstable areas as above shall serve as bedding. The minimum thickness of bedding material shall be 2 inches.

c. Placing and Backfilling. Culverts shall be placed so that the minimum distance from the subgrade to the top of the culvert shall be 12 inches for all culverts in Category 1, or as shown on Drawings.

The culvert shall be laid with the sections joined firmly together and with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides.

Backfill shall be a readily compactible soil free from frozen lumps and stones larger than 3 inches, chunks of highly plastic clay, or other deleterious material. Material shall be placed and compacted under the haunches and alongside the culvert in layers not to exceed 6 inches and compacted. Filling and compacting shall be continued until the backfill is in place 8 inches above the top of the culvert.

For ditch relief culverts, the final installed location of the inlet end of the culvert shall not vary more than 10 feet horizontally from the location shown on Drawings, unless otherwise agreed and staked on the ground. Inlet invert elevation will be as shown on the typical cross section, relative to ditch elevation at the point of installation. Skew of culvert will be as shown on the Drawings or staked on the ground with a maximum 5 degree tolerance.

For Category I culverts under through fills or intermittent drainages, culvert alignment and grade will approximate alignment and grade of the

original natural drainage or natural groundline as closely as possible. Such alignment and grade will be measured at the deepest (lowest) elevation of the original natural channel unless otherwise shown on Drawings.

The final installed alignment of the culverts shall be such that no point shall vary from a straight line drawn from inlet to outlet by more than 2 percent horizontally and vertically of the culvert length, but not to exceed 1 foot.

3.3 Category II Culverts. Category II culverts are the following: Culverts with fill heights over 10 feet at subgrade centerline, or culverts in live streams (at the time of installation) or which are round culverts 48 inches and greater in diameter, or which are pipe arches with spans of 50 inches and greater.

a. Excavation. The width of the trench shall be adequate to permit satisfactory jointing and thorough tamping of the bedding material under and around the culvert.

Unstable foundation material shall be excavated below the flow line of the culvert to an approximate depth of 2 feet and for a width of at least one diameter plus 4 feet. Unstable material thus excavated will be replaced with selected granular material properly compacted to provide adequate support for the pipe.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 12 inches or $\frac{1}{2}$ inch for each foot of fill over the top of pipe, whichever is greater, but not to exceed three-quarters of the vertical inside diameter of the pipe. The width of the excavation shall be at least 1 foot greater than the horizontal outside diameter of the pipe. Material thus excavated will be replaced with selected material, such as silty clay or loam, and lightly compacted in layers to form a uniform but yielding foundation.

b. Bedding. The bedding surface shall provide a foundation of uniform density throughout the entire length of the culvert and shall provide for camber along the culvert centerline as shown on Drawings to correct for settlement and insure tight joints in the lower half of the culvert.

The bed for the culvert shall be shaped to fit the lower part of the culvert exterior for at least 10 percent of its diameter throughout its length. The minimum thickness of bedding material beneath the pipe shall be 4 inches. The bedding material shall be selected mineral soil.

c. Placing and Backfilling. No culvert in this size group shall be placed or backfilled until the excavation and foundation have been approved.

Culverts shall be laid true to line and grade as staked on the ground or shown on Drawings.

The culvert shall be laid with the sections joined firmly together and with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides.

When called for on the Drawings, culverts shall be factory elongated, tied, or strutted. Struts shall be installed before embankment is placed and struts or ties shall be removed after embankment is completed or when no longer necessary. Struts or ties shall be removed at the end of each construction season, regardless of stage of completion of embankment, and replaced, if necessary, when construction resumes.

After the bedding is prepared and the culvert placed, selected material shall be placed and compacted under the haunches and alongside the culvert in layers not exceeding 6 inches in depth. The material shall be of a moisture content needed for effective compaction. Backfill shall be readily compactible material free from frozen lumps and chunks of highly plastic clay or other objectionable material. No rock larger than 3 inches in diameter will be used within 1 foot of the culvert. On each side of the culvert, there shall be an area of compacted material at least as wide as two diameters of the culvert or 12 feet, whichever is less. Backfill shall be compacted (caution should be taken in order to prevent damage to the culvert). Filling and compacting shall be continued until the backfill is in place 12 inches above the top of the culvert.

Culverts not thus installed shall be removed, replaced, or reinstalled as necessary.

SPECIFICATION 41 - STRUCTURAL PLATE CULVERT

Description

1.1 This work shall consist of furnishing, as specified in materials list, and installing, or installing only, structural plate pipe, pipe arches, or arches of the sizes, thicknesses, and materials shown on Drawings or otherwise designated and in accordance with these specifications and in reasonable conformity with the lines and grades established. This work shall include such joints, connections, catch basins, headwalls, and concrete blankets as required to complete the structure as shown on Drawings, or otherwise designated, and includes excavation, bedding, and backfilling for culverts required to complete the structures as shown on Drawings.

Materials

2.1

a. Materials and fabrication shall meet the requirements of Federal Specification WW-P-405a or WW-P-402c as current at the time of advertisement.

b. Where elongated structural plate culvert is called for on Drawings, plates shall be factory formed so that the finished culvert is an approximate ellipse in cross section with the vertical diameter 5 percent greater and the horizontal diameter 5 percent less than the specified nominal diameter.

c. The thickness shown on Drawings shall govern unless otherwise agreed.

d. When skewed and/or beveled ends are required, plates shall be factory cut to give the angle of skew and/or bevel specified, and corrected where grade of culvert exceeds 4 percent.

Construction Requirements

3.1 Excavation. Excavation shall be adequate to permit satisfactory erection and thorough tamping of the bedding material under and around the culvert, or to permit removal of unsuitable material.

Unstable foundation material shall be excavated below the flow line of the culvert to an approximate depth of 2 feet and for a width of at least one diameter (or span) plus an additional 2 feet each side of the culvert. The excavated area shall be backfilled to the flow line grade with suitable material.

Where rock or other unyielding material is encountered and must be excavated, such material shall be removed below the foundation grade of the culvert for a depth of approximately 2 feet and backfilled with suitable material compacted to form a firm foundation.

The bedding surface shall provide a foundation of uniform density throughout the entire length of the culvert, and shall provide for camber along the culvert centerline as shown on Drawings to correct for settlement.

Structural plate culvert shall not be placed or backfilled until the excavation and foundation have been approved.

3.2 Erection. Structural plate culvert, pipe arches, and arches shall be erected in their final position by connecting the plates with bolts at all seams. Drift pins may be used to facilitate matching of holes. All plates shall be placed in the order recommended by the manufacturer with joints staggered so that not more than three plates come together at any one point. Before beginning the backfill, all bolts shall be torqued to a minimum of 150 ft. lbs., but not more than 250 ft. lbs. Where elongated culvert is used, the culvert shall be installed with the long diameter vertical.

3.3 Backfill. After the bedding is prepared and approved by the Forest Service and the culvert is assembled, selected material shall be placed and compacted under the haunches and alongside the culvert in layers not exceeding 6 inches in depth. Each layer shall be moistened or dried as necessary for effective compaction. No rock larger than 3 inches in diameter shall be used within 1 foot of the culvert. On each side of the culvert, there shall be an area of compacted material at least as wide as two diameters of the culvert, not to exceed 12 feet. Backfill shall be compacted. (Caution should be taken in order to prevent damage to the culvert.) Filling and compaction shall be continued until the backfill is in place to an elevation adequate to support construction equipment over structure.

The culvert shall be so placed that the minimum distance from subgrade to the top of the structure shall be as shown on Drawings. During construction, adequate fill cover must be provided to protect the culvert from damage.

3.4 Backfill for Arches. Backfill material and compaction shall meet the requirements of 3.3 "Backfill."

When backfilling arches before headwalls are placed, the first material shall be placed midway between the ends of the arch, forming ramps as narrow as possible until the top of the arch is reached. The ramps shall be built evenly from both sides and the backfilling material shall be thoroughly compacted as it is placed. After the ramps have been built to the top of the arch, the remainder of the backfill shall be deposited from the top of the arch both ways from the center to the ends as evenly as possible on both sides of the arch.

If the headwalls are built before the arch is backfilled, the filling material shall first be placed adjacent to one headwall, until the top of the arch is reached, after which the fill shall be dumped from the top of the arch toward the other headwall, with care being taken to deposit the material evenly on both sides of the arch.

In multiple installations, the procedures specified above shall be followed and extreme care shall be used to bring the backfill up evenly on each side of each arch so that unequal pressure will be avoided.

3.5 Workmanship. The following defects, which are not all inclusive, are indicative of poor workmanship, and the presence of any or all of them in any individual culvert plate or in any culvert shall constitute sufficient cause for rejection.

- a. Uneven laps
- b. Variation from a straight centerline
- c. Ragged edges
- d. Loose, unevenly lined or spaced bolts
- e. Illegible brand
- f. Bruised, scaled, or broken spelter coating
- g. Dents or bends in the metal itself

SPECIFICATION 42 - UNDERDRAIN

Description

1.1 This work shall consist of furnishing and installing, or installing only, perforated pipe or other pipe and filter material for underdrains in reasonable conformity with lines and grades, size, and materials shown on Drawings or as otherwise designated. The work shall also include necessary excavation, bedding, and backfill.

Materials

2.1 Underdrain pipe of the various materials shown in materials list shall conform to the following specifications as current at the time of advertisement:

Perforated Corrugated Galvanized Metal Pipe	Fed. Spec. WW-P-405a
Bituminized Coated Corrugated Metal Pipe	AASHO M-190
Perforated Corrugated Aluminum Alloy Pipe	Fed. Spec. WW-P-402c
Perforated Concrete Pipe	AASHO M-175
Asbestos-Cement Perforated Pipe	AASHO M-189
Perforated Clay Pipe	AASHO M-65
Perforated Bituminized-Fiber Drainage Pipe	AASHO M-177

2.2 Filter material shall consist of hard, durable, and clean sand, gravel, or crushed rock. Filter material shall meet the gradation shown on Drawings.

Construction Requirements

3.1 Trenching and Bedding. Underdrains shall be installed at locations shown on Drawings or staked on the ground. Trenches shall be excavated

to a width equal to the outside diameter of the pipe plus 2 feet and to a depth 4 inches below the grade established for the flow line. A 4-inch bedding of filter material shall be spread in the bottom of the trench and brought to a uniform grade so that the pipe, when laid, will be at the proper grade.

3.2 Placing Pipe. The pipe shall be imbedded firmly in the bedding material with the separate sections firmly joined and held in alignment with approved type bands or connectors. Perforations shall be turned either up or down as shown on Drawings. If perforations are to be turned up, they shall be covered with heavy tarpaper. The pipe, when placed, shall be inspected and approved before backfilling.

3.3 Cleanout Risers. Cleanout risers shall be installed as designated on Drawings.

3.4 Backfilling. Filter material shall be carefully backfilled around and over the pipe in layers not to exceed 6 inches and thoroughly tamped. Care shall be exercised not to displace the pipe or joints. Backfilling shall continue in this manner to a point at least 12 inches above the top of the pipe.

The remainder of the trench above the filter material shall be backfilled using approved material provided from borrow and excavation.

SPECIFICATION 43 - DOWNPIPE

Description

1.1 This work shall consist of furnishing and installing, or installing only, downpipe (culvert extension down a fill slope) assembled by using an elbow at the end of a culvert pipe with a downpipe anchored in place. Installation shall be in accordance with these specifications, as shown on Drawings, and in reasonable conformity with the lines and grades established. This work shall include the furnishing and installing of such joints, connections, and anchors as applicable.

Materials

2.1 The material used to fabricate the metal parts of the downpipe as shown on materials list shall meet the requirements of the following specifications: Federal Specification WW-P-405a or Federal Specification WW-P-402c, as current at the time of advertisement unless otherwise provided on Drawings.

2.2 Fabrication. All materials shall be fabricated in accordance with the details shown on Drawings unless otherwise agreed.

2.3 Other Materials. Each downpipe installation shall be assembled from materials compatible to prevent electrolysis or physical failure.

Construction Requirements

3.1 General. The downpipe and elbow shall be installed and anchored or buried as shown on Drawings. The culvert pipe may be torch cut, sheared, or sawed to the desired length for proper installation of the downpipe. When lap-seamed pipe is used, it shall be laid with the outside laps of the circumferential seams pointed upward, and the longitudinal laps on the sides. Bedding and backfilling shall be done so that the pipe and elbow shall have a firm and uniform bearing. The completed slope on which the downpipe is installed shall present a relatively smooth appearance.

SPECIFICATION 50 - AGGREGATE BASE COURSE (PIT RUN)

Description

1.1 This work shall consist of furnishing, hauling, spreading, watering, grading, and compacting pit run aggregate on prepared subgrade, in accordance with the lines, grades, and dimensions shown on Drawings or as established by Forest Service.

Materials

2.1 The material shall be obtained from sources shown on the Drawings or other approved sources.

Pit run aggregate shall consist of gravel, talus rock, disintegrated granite, semigravel, sand, caliche, shale, scoria, clinkers, cinders, or other suitable material. Base course materials shall be reasonably free from vegetative matter or other objectionable substances. The maximum dimension of any particle shall not be greater than two-thirds the compacted thickness of the layer in which it is placed. Oversize material may either be removed or broken down to the specified dimension by any method which accomplishes reduction to that size. The removal or the breakdown of oversize material to the specified size shall be done at the material source.

2.2 Filler or Binder. If filler, in addition to that naturally present in Base Course material, is necessary for satisfactory binding of the material, it shall be uniformly blended with Base Course on the road.

Construction Requirements

3.1 Placing. Base Course material, as necessary and as agreed to reinforce subgrade shall be placed in accord with 3.1 of the Roadway Excavation Specification applicable to the road segment receiving Base Course hereunder.

Base Course material used to distribute wheel loads shall be placed in approximately its final position on approved subgrade and shall be spread in such a manner as to avoid segregation. If segregation does occur, the material shall be blade-processed until uniformly mixed.

Where the specified Base Course used to distribute wheel loads is 8 inches or less, it may be spread and compacted in one layer. Where the course is

more than 8 inches, Base Course shall be spread and compacted in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed 8 inches. Base Course used for subgrade reinforcement may be deposited in layers of thickness adequate to support construction equipment.

3.2 Compactions. Aggregate shall be moistened or air dried to obtain a moisture content suitable for attaining the required compaction. Unless shown otherwise on Drawings, the material shall be compacted by operating spreading and hauling equipment, to the extent possible, over the full width of each layer of the material.

SPECIFICATION 51 - AGGREGATE BASE COURSE (SCREENED)

Description

1.1 This work shall consist of furnishing, hauling, and placing one or more courses of screened aggregate, and additives if needed, on the prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, thickness, and typical cross sections shown on Drawings.

Materials

2.1 Material to be used shall be obtained from sources shown on the Drawings or other agreed sources and shall consist of gravel, talus, rock, sand, shale, scoria, or other suitable material. The material shall meet the gradation requirements designated on Drawings.

2.2 Quality. All Base Course material shall be reasonably hard and durable and reasonably free of organic material, mica, clay lumps, or other deleterious materials.

Construction Requirements

3.1 Subgrade Preparation. Subgrade shall be completed as specified prior to the placement of Base Course.

3.2 Placing. Base Course material, used as necessary and as agreed to reinforce subgrade, shall be placed in accord with 3.1 of the Roadway Excavation Specification applicable to road segment receiving Base Course hereunder.

Base Course material used to distribute wheel loads shall be placed in approximately its final position on approved subgrade and shall be spread in such a manner as to avoid segregation. If segregation does occur, the material shall be blade-processed until uniformly mixed. Where the specified Base Course for distribution of wheel loads is 6 inches or less, it may be spread and compacted in one layer. Where such course is more than 6 inches, Base Course shall be spread and compacted in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.

Base Course shall not be placed on subgrade when the moisture content of the materials exceeds 15 percent.

3.3 Mixing and Spreading. After each layer of Base Course material has been placed, it shall be thoroughly mixed to its full depth by means of power graders, traveling mixers, or other approved mixing equipment. Aggregate shall be moistened or air-dried as necessary to obtain a moisture content suitable to obtain satisfactory compaction. When satisfactorily mixed, the material shall be spread smoothly to a uniform thickness to the cross section shown on Drawings. The mixing and spreading operation shall be scheduled so as to insure completion of spreading and compacting immediately after placing.

3.4 Compacting. The surface of each layer shall be bladed during the compaction operations to remove irregularities and produce a smooth, even surface compacted to within plus or minus 1 inch of the specified thickness.

3.5 Stockpiling. If Purchaser elects to stockpile material, sites shall be at agreed locations. Sites shall be cleaned and leveled to a uniform section prior to any stockpiling.

Stockpiles shall be neat and regular in form, and shall occupy as small an area as is reasonably possible. Reasonable care should be taken to avoid segregation. Material stored in stockpiles shall meet grading requirements after processing on the road.

SPECIFICATION 52 - AGGREGATE BASE COURSE (CRUSHED)

Description

1.1 This work shall consist of furnishing, hauling, and placing one or more Base Courses of crushed aggregate, and additives if required, on prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, thickness, and typical cross sections shown on Drawings.

Materials

2.1 The material shall be obtained from sources shown on the Drawings, or other agreed sources.

The material shall consist of stone, gravel, or slag, or other suitable materials, crushed to required size and with a binder or filler of fine mineral material. For purposes of this specification, the portion of the material retained on a No. 4 sieve is considered as coarse aggregate and that passing a No. 4 sieve as filler or binder. At least 50 percent by weight of the coarse aggregate particles shall be particles having at least one fractured face unless the natural material has sufficient angularity to provide necessary binding quality.

Materials shall conform to the following quality requirements unless modified by notes on Drawings and Specifications List.

Loss in Los Angeles Abrasion Test
AASHTO T-96-65 (after 500
revolutions) (Test for resistances
to abrasion)

Percentage of
original weight -
40% maximum

Production of Plastic Fines (Both
Course and Fine Aggregate) (AASHTO
T-210) (Test for durability of
aggregates)

Durability index -
35 minimum

Sand Equivalent (AASHTO T-176)
(Rapid field test to show relative
proportions of plastic fines in
aggregates)

Sand Equivalent
value - 35
minimum

2.2 Gradation. Grading shall be as noted on Drawings. Grading specified will conform to the sizes shown in the following tables or as noted on the Drawings.

OPEN GRADED

<u>Sieve Designation</u>	Percentages by weight passing square Mesh sieves (AASHO T-27 and T-11)			
	Grading A	Grading B	Grading C	Grading D
3-inch	100			
2-inch		100		
1-½ inch	50-95	70-100	100	
1-inch	35-80	50-90	65-100	100
¾-inch			55-90	70-100
No. 4	10-45	15-50	20-55	25-55
No. 40				5-20
No. 200	0-10	0-12	0-15	0-15

DENSE GRADED

<u>Sieve Designation</u>	Percentages by weight passing square Mesh sieves (AASHO T-27 and T-11)			
	Grading E	Grading F	Grading G	Grading H
3	100			
2	65-95	100		
1-½			100	
1		60-90		100
¾	40-75		60-90	70-98
½		44-70		
No. 4	22-45	28-50	30-55	36-65
No. 40	6-22	8-25	10-25	12-30
No. 200	2-10	3-12	3-15	3-15

2.3 Filler or Binder. This material shall consist of mineral particles added to meet the grading requirements and shall be blended with the aggregate during the crushing operations.

Construction Requirements

3.1 Subgrade Preparation. Subgrade shall be compacted as specified, prior to the placement of Base Course.

3.2 Placing. Base Course material shall be placed uniformly on approved roadbed in the quantities necessary to produce layers of the thickness shown on Drawings or as necessary and as agreed to stabilize weak spots in subgrade. Where the specified Base Course thickness is 6 inches or less, it may be spread and compacted in one layer. Where the course is more than 6 inches, Base Course shall be spread and compacted in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches. When more than one layer is required, each layer shall be shaped and compacted before the succeeding layer is placed. Base Course shall not be placed on subgrade when the moisture content of the materials exceeds 15 percent.

3.3 Mixing and Spreading. After each layer of Base Course has been placed, if segregated, it shall be thoroughly mixed to its full depth by means of power graders, traveling mixers, or other approved mixing equipment.

Aggregate shall be moistened or air dried as necessary to obtain a moisture content suitable to obtain satisfactory compaction. When satisfactorily mixed, the material shall be spread smoothly to a uniform thickness and to the cross section shown on Drawings. The mixing and spreading operation shall be scheduled so as to insure completion of spreading and compacting immediately after placing.

3.4 Compacting. The surface of each layer shall be bladed during the compaction operations to remove irregularities and produce a smooth, even surface compacted to within plus or minus 1 inch of the specified thickness.

3.5 Stockpiling. If operator elects to stockpile material, sites shall be at agreed locations. Site shall be cleaned and leveled to a uniform section prior to any stockpiling. Stockpiles shall be neat and regular in form, and shall occupy as small an area as is reasonably possible. Reasonable care should be taken to avoid segregation.

Materials stored in stockpiles shall meet grading requirements after processing on the road.

3.6 Test Location. Acceptance tests shall be made from samples taken from materials in place on the road. Any test data obtained by Forest Service from testing materials shall be made available to the operator.

SPECIFICATION 60 - OIL DUST PALLIATIVE

Description

1.1 This work shall consist of furnishing and applying dust oils which shall be a mixture of asphaltic petroleum products, blended to meet one of the following specifications for light, medium, or heavy grade dust oils.

Materials

2.1 Quality. Dust oils shall be of the grade shown on Drawings and shall conform to the requirements of the following specifications:

	ASTM Method	Grade		
		Light	Medium	Heavy
Flash Point, °F, (Open Tag.), Min.	D1310	125	125	125
Viscosity 100°F., Kinematic CS	D2170	40-70	90-135	145-200
Water, % Max.	D95	0.5	0.5	0.5
Asphaltenes %	D2006- 6ST	3-6	4-7	5-8
Paraffins, % Min.	D2006- 6ST	25	25	25

DISTILLATION:

Total Distillate to 550°F., Max. %	*D402	35	30	30
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Tests on Residue from Distillation to 550° F.:

Viscosity 100°F., Kinematic CS	D2170	75-250	200-630	540-1500
Solubility in trichlorethylene, % Min.	**D2042	98	98	98

* Except that the residue remaining after a temperature of 550°F. (instead of 680°F.) shall be used for further testing.

** Trichlorethylene shall be used as a solvent instead of carbon disulfide.

2.2 Temperature. The temperature of the material at the time of loading into a tank car or truck and at any time after loading until delivery by the supplier shall not be more than 140°F.

2.3 Certification. Operator shall furnish with each delivery of dust oil, certified scale weights and a certificate of compliance which states that the dust oil supplied complies with these specifications.

Construction Requirements

3.1 Conditioning of Road Surface. Prior to application of dust oil, the roadbed shall be properly graded, watered, shaped, and compacted in conformity with the lines, grades, and dimensions shown on Drawings.

3.2 Weather Limitations. Dust oils shall be applied only when the surface to be treated has a moisture content of 2 percent to 5 percent in the top 2 inches, and when the atmospheric temperature in the shade is above 55°F. and steady or rising.

3.3 Equipment. Dust oil shall be applied by a pressure distributor with full circulating spraybar, equipment for heating material, thermometer, and an accurate volume-measuring device or calibrated tank. The distributor shall also be equipped with a hose and nozzle attachment to cover areas missed or inaccessible to the distributor.

3.4 Application. Dust oil shall be applied in one or more applications at the rates shown on Drawings. Distribution shall be uniform and with an allowable variation of 0.04 gallons per square yard from the directed rate. Application shall be at such temperatures that the viscosity (Saybolt-Fural-Seconds) shall not be less than 25 nor more than 100. In lieu of temperature viscosity data, the application temperature shall be from 80°F. to 125°F.

SPECIFICATION 61 - BITUMINOUS PRIME COAT

Description

1.1 This work shall consist of furnishing and applying a prime coat of bituminous material to a previously prepared aggregate roadbed in accordance with these Specifications and in conformity with the lines, grades, and dimensions shown on Drawings.

Materials

2.1 Bituminous Material. Bituminous materials shall be of the type and grade called for on Drawings and shall conform to the requirements of the specifications listed below.

Rapid-Curing (RC), Medium-Curing (MC), and Slow-Curing (SC) liquid asphalt:

ASTM Specifications, Designation: D2026, D2027, and D2028.
Application temperatures (in degrees F.) will be as follows:

RC - 70 (105° - 175°)	MC - 30 (50° - 120°)
RC - 250 (140° - 225°)	MC - 70 (90° - 155°)
"Penepriime" (130° - 145°)	MC - 250 (125° - 200°)
	SC - 70 (90° - 155°)

2.2 Bituminous Additive. Additive shall be used when shown on Drawings.

2.3 Blotter Material. Blotter material shall be a clean sand or other granular material.

Construction Requirements

3.1 Weather and Seasonal Limitations. Prime coat shall be applied only when the surface aggregate to be treated is dry, or slightly damp, when not excessively windy, and only when the atmospheric temperature in the shade is above 55°F., and rising; or above 60°F., if falling; and when the weather is not foggy or rainy.

3.2 Equipment. The equipment used shall include a grader, roller, water distributor, and if needed, a power broom and/or a power blower, a self-powered pressure bituminous material distributor, a blotter spreader, and equipment for heating bituminous material if necessary.

The asphalt distributor shall be equipped with a pump and a full circulating spray bar which is fully adjustable. The unit shall include a tachometer, pressure gages, accurate volume-measuring devices, such as a visual volume dial or gage calibrated to the tank, and a tank thermometer. All equipment shall be of standard modern commercial type which will provide satisfactory performance.

3.3 Preparation of Surface for Treatment. The gravel surfacing shall be shaped, thoroughly compacted, and dampened or dried as necessary prior to applying the prime coat. All loose and foreign material shall be removed by brooming.

3.4 Application of Bituminous Material. The bituminous material shall be applied at the rates shown on Drawings, so that a uniform distribution is obtained at all points. The material shall be applied within the temperature range stated in the specifications for the particular material being used. When heating is required, suitable precaution shall be taken to avoid fire.

The surfaces of structures and trees adjacent to the road being treated shall be protected to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

When necessary to provide for traffic, the bituminous material shall be applied in alternate lanes of approximately one-half the width of the completed surface, if practicable. Under no condition shall traffic be allowed to travel over the freshly primed surface. If detours cannot be provided or the road closed to traffic, operator shall restrict operations to a width which will permit at least one-way traffic over the remaining portion of the road. If one-way traffic is provided, it shall be controlled by flagging or pilot car operation so as to adequately protect the traveling public and the work.

3.5 Maintenance and Opening to Traffic. After the prime coat of bituminous material has been applied, it shall be left undisturbed with no traffic permitted until the material has penetrated and cured so that it will not pick up under traffic. Any portions of road containing an excess or deficiency of priming material shall be corrected by the addition of blotter material or bitumen. The prime coat shall be allowed to cure for a minimum of 6 hours or until the diluent has evaporated from the material before the next course is applied.

Operator shall maintain the prime surface until the next course is applied. If it becomes necessary to permit traffic on the prime coat, maintenance shall include spreading blotter material as necessary to prevent adherence of the prime coat to tires of vehicles, and treating any breaks in the primed surface with additional bituminous material. Any area that has become fouled by traffic or otherwise damaged shall be corrected before the next course is applied.

SPECIFICATION 62 - BITUMINOUS TREATED BASE

Description

1.1 This work shall consist of a Base Course composed of aggregate and bituminous material constructed on prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and dimensions shown on Drawings.

Aggregate may be either new imported material or material scarified from the existing subgrade as specified in Drawings.

Materials

2.1 Bituminous Material. Bituminous materials shall be of the types and grades called for on Drawings and shall conform to the applicable AASHO Specification.

2.2 Bituminous Additive. Additive shall be used when shown on Drawings or directed by Forest Service.

2.3 Aggregate. Aggregate shall be a granular material, and may vary from a well-graded crushed or pit run gravel to a fine sand. Operator shall not be responsible for the grading or quality of the existing aggregate scarified from the road.

Construction Methods

3.1 Quantities of Materials. The percentage of bituminous material to be added will normally be between 2 and 10 percent, by weight, of the dry aggregate. The exact percentages and grades shall be as specified on Drawings.

3.2 Weather and Temperature Limitations. Bituminous material shall be applied when subgrade is slightly damp, and only when the air temperature in the shade is above 55°F., and rising; or above 60°F., if falling; and when the weather is not foggy or rainy.

3.3 Equipment. Operator shall provide equipment for grading, scarifying (if needed), and watering; a traveling mixing plant equipped to add and control water and bituminous material, or a stationary mixing plant and hauling equipment; and spreading, finishing, and compacting equipment. All equipment shall be standard, modern, commercial types of proven performance.

3.4 Preparation of Surface. When central plant mixing is specified or approved, the surface on which the bituminous treated base is to be placed shall be thoroughly compacted and shaped to the required line, grade, and cross section at the time the treated base is placed.

3.5 Placing New Aggregate. Aggregate shall be placed upon the prepared surface by means of a windrow placing device, or by uniformly spreading followed by blade windrowing.

3.6 Aggregate from Existing Subgrade. The existing surface shall be scarified lightly and bladed to a uniform grade and cross section. This reshaped surface shall then be scarified again to such depth as necessary to produce the required aggregate and in such a manner as to leave a foundation stratum of undisturbed material parallel to the proposed finished surface. The scarified or loosened material shall be bladed into a windrow and the undisturbed base rolled and watered.

3.7 Windrowed Aggregate. New aggregate or aggregate from subgrade shall be placed in uniform windrows that can be measured. Water shall be added prior to final windrowing. Each windrow shall be of such size that the rated capacity of the traveling plant is not exceeded. There shall be sufficient material in the windrow or windrows to provide a base of the required compacted thickness and width. These windrows shall be left undisturbed approximately one day until measuring and sampling are completed.

3.8 Road Mixing. The bituminous material and water in the quantities specified by Forest Service shall be added to the windrowed aggregate during the mixing operation. Mixing shall continue after the initial mixing operation by repeated trips of the mixing plant or by sidecasting with a motor patrol, or both, until an aerated, thoroughly coated mixture which is uniform in color and texture is obtained.

3.9 Central Plant Mixing. Approved aggregate shall be stockpiled at the plant. The specified quantity of bituminous material and water shall be such as to produce an aerated, thoroughly coated mixture which is uniform in color and texture.

The specified quantity of the central plant mixture shall be uniformly placed and spread on approved subgrade. When the mixture cannot be finished during that day, it shall be windrowed for overnight storage.

3.10 Spreading, Compacting, and Finishing. The windrowed mixture, aerated, if necessary, to the proper moisture content for compaction, shall be uniformly spread. The section or length of spread shall be limited so that the finishing and compacting can be completed within the same day.

The surface of the base shall conform to the required line, grade, and cross section when compaction is complete.

Compaction shall commence at the outer edges of the road and progress toward the center in such a way that displacement of the material is kept to a minimum. The final rolling or compacting shall be done with a 3-wheel or tandem type roller or vibratory compacter to remove any corrugation effect. The base shall be kept smooth, compact, and clean until the surface treatment is placed.

3.11 Completed Surface. The finished surface shall be tested by laying a 10-foot straightedge parallel to the centerline. The surface shall not vary more than $\frac{1}{4}$ inch from the lower edge of this straightedge. Variations exceeding the limitations shall be corrected in an approved manner.

SPECIFICATION 63 - BITUMINOUS SURFACE TREATMENT

Description

1.1 This work shall consist of applying a bituminous prime coat on a prepared surface followed by inverted penetration applications of bituminous material and cover aggregate in accordance with these Specifications and to the lines, grades, and dimensions and "type" surface treatment shown on Drawings.

a. Type "A" Surface Treatment shall be a bituminous prime coat followed by a single course application of bituminous material and cover aggregate.

b. Type "B" Surface Treatment shall be a bituminous prime coat followed by a two-course application of bituminous material and cover aggregate.

c. Type "C" Surface Treatment shall be a bituminous prime coat followed by a three-course application of bituminous material and cover aggregate.

Materials

2.1 Bituminous Material. Bituminous materials shall be of the type and grade called for on Drawings and shall conform to the requirements of the Specifications listed below:

Rapid Curing (RC) liquid asphalt	AASHTO M-81
Medium Curing (MC) liquid asphalt	AASHTO M-82
Emulsions (anionic)	AASHTO M-140
Emulsions (cationic)	AASHTO M-208

Application temperatures (in degrees F.) shall be within the following limits:

MC or RC-70	(105° - 175°)
MC or RC-250	(140° - 225°)

MC or RC-800 (175⁰ - 225⁰)

MC or RC-3000 (215⁰ - 290⁰)

RS-1 (75⁰ - 130⁰)

RS-2 (110⁰ - 150⁰)

RS-K (110⁰ - 150⁰)

CRS-2 (110⁰ - 170⁰)

2.2 Bituminous Additive. Additive shall be used when shown on Drawings.

2.3 Cover Aggregate. Cover aggregate shall be screenings of crushed stone or gravel free from dirt, clay balls, vegetable matter, and other deleterious substances. The material shall consist of clean, durable particles of aggregate meeting the following grading requirements:

Percentage by weight passing square mesh sieves, as determined by AASHO T-11 and T-27.

<u>Sieve Designation</u>	<u>Grading X</u>	<u>Grading Y</u>	<u>Grading Z</u>
3/4 inch	100		
1/2 inch	90-100	100	100
3/8 inch	40-75	90-100	75-100
No. 4	0-15	10-30	0-10
No. 10	0-5	0-8	0-2
No. 200	0-2	0-2	

The aggregate shall further conform to the following requirements as determined by the listed AASHO designation:

Unit Weight-Loose	AASHO T-19	Not less than 80 lbs. pcf.
Percent of Wear	AASHO T-96	Not more than 40
Stripping Test	AASHO T-182	Minimum 95 percent coated
Soundness	AASHO T-104	Not more than 10, total Sample 5 cycle, sodium sulfate

Not less than 70 percent of the material retained on the No. 4 sieve shall be particles having at least one fractured face.

Blotter material shall be clean sand or other fine granular material.

Construction Requirements

3.1 Weather and Temperature Limitations. Bituminous material shall be applied only when the surface to be treated is dry or slightly damp, when the air temperature in the shade is above 55°F., and rising, or above 60°F., if falling, and when the weather is not foggy or rainy.

3.2 Equipment. The equipment used shall include a grader, roller, water distributor, chip spreader, power broom, a self-powered pressure bituminous material distributor, and equipment for heating bituminous material when necessary.

The asphalt distributor shall be self-powered and mounted on pneumatic tires. It shall be equipped with a pump and a full circulating spray bar which is fully adjustable. The unit shall include a tachometer, pressure gages, heating device, accurate volume-measuring devices such as a visual volume dial or gage calibrated to the tank, and a tank thermometer.

All equipment shall be of standard, modern, commercial type of proven performance.

3.3 Preparation of Surface for Treatment. The base material shall be finally shaped, thoroughly compacted, and dampened or dried as necessary prior to applying the prime coat. All loose and foreign material shall be removed by brooming.

3.4 Application of Bituminous Material. The bituminous material shall be applied at the rates shown on Drawings so that a uniform distribution is obtained at all points. The material shall be applied within the temperature range stated in the Specification for the particular material being used. When heating is required, suitable precautions shall be taken to avoid fire.

The surfaces of structures and trees adjacent to the area being treated shall be protected in such a manner as to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

When necessary to provide for traffic, the bituminous material shall be applied in alternate lanes of approximately one-half the width of the completed surface, if practicable. Under no conditions shall traffic be allowed to travel over the freshly primed surface. If detours cannot be provided, and the road must remain open, operator shall restrict operations to a width which will permit at least one-way traffic over the remaining portion of the road. If one-way traffic is provided, it shall be controlled by flagging or pilot car operations, so as to protect the traveling public and the work.

3.5 Sequence of Operation. Bituminous surface treatment shall be applied in the sequence of operation as outlined below:

<u>Sequence of Operation</u>	<u>Type A</u>	<u>Type B</u>	<u>Type C</u>
Prime Coat			
Apply bituminous material	*	*	*
1st Course	*	*	*
Apply bituminous material	*	*	*
Spread cover aggregate	*	*	*
Broom and rolling	*	*	*
2nd Course			
Apply bituminous material		*	*
Spread cover aggregate		*	*
Broom and rolling		*	*
3rd Course			
Apply bituminous material			*
Spread cover aggregate			*
Broom and rolling			*

3.6 Prime Coat. After the prime coat of bituminous material has been applied, it shall be left undisturbed with no traffic permitted until the material has penetrated and cured and will not pick up under traffic. Any areas containing an excess or deficiency of bituminous material shall be corrected by the addition of blotter material or bitumen. The prime coat shall be allowed to penetrate and cure undisturbed for a minimum of 6 hours before the next course is applied. Spots of excess bitumen remaining at the end of the period shall be lightly covered with blotter material.

Purchaser shall maintain the primed surface until the next course is applied. If it becomes necessary to permit traffic on the prime coat, maintenance shall include spreading blotter material as necessary to prevent adherence of the prime coat to tires of vehicles and treating any breaks in the primed surface with additional bituminous material. Any area that has become fouled by traffic or otherwise damaged shall be corrected before the next course is applied.

Immediately prior to placing the next application, all blotter material, dirt, or other objectionable material shall be removed from the primed surface.

3.7 Cover Aggregate Courses. Before the bituminous material is applied, sufficient aggregate to cover the distributor load of bitumen shall be in trucks at the site of the work.

Initial spreading of cover aggregate shall be done within 5 minutes after application of bitumen. Trucks hauling or spreading aggregate shall be operated so that bituminous material will be covered before truck wheels pass over it.

Immediately after spreading, the cover aggregate shall be smoothed by hand brooming, if necessary, to distribute the cover aggregate uniformly over the surface. The surface shall then be rolled and alternately broomed and rolled, until the aggregate is uniformly and thoroughly embedded and bonded over the entire surface. The initial rolling pass shall be made with a steel wheel tandem or three-wheel roller within 15 minutes after placing the bitumen. Rolling with pneumatic tire roller shall begin immediately after completion of initial rolling and shall consist of not less than two complete coverages or as necessary for complete bonding of the aggregate.

An interval of at least 24 hours shall elapse between the application of each course, during which period the surface shall be opened to traffic and maintained by operator by brooming and rolling to retain complete coverage of aggregate.

To prevent lapping at an end junction of two applications, building paper or other material shall be spread over the treated section to allow the distributor to be operating at full force and speed when reaching the untreated section.

Operator shall furnish a pilot car to conduct traffic over each completed course at a maximum speed of 15 miles per hour for the first 24 hours after cover aggregate is applied.

Operator shall maintain the last course for a period of 5 days or as otherwise approved. Maintenance shall include light brooming or the addition of cover aggregate to absorb any free bituminous material and rolling areas where there are indications of a lack of surface tightness. Care shall be taken in maintenance to prevent disturbance of aggregate in contact with bituminous material.

SPECIFICATION 64 - BITUMINOUS SEAL COAT

Description

1.1 This work shall consist of applying a seal coat of bituminous material with or without cover aggregate to a previously bituminized roadbed in accordance with these Specifications and to the width shown on Drawings.

Materials

2.1 Bituminous Material. Bituminous material shall be of the type and grade called for on Drawings, and shall conform to the requirements of the Specifications listed below:

Rapid-Curing (RC), Medium-Curing (MC) Liquid Asphalt
AASHO Specification, Designation M81 and M82:

Emulsified Asphalt:
Anionic AASHO M-140
Cationic AASHO M-208

When the drawings call for Diluted Emulsified Material, the specified dilution shall be done at the plant using heated, soft water.

Application temperatures (in degrees F.) shall be within the following limits:

RC - 250 (140-225)	RS - 1 (75-130)
RC - 800 (175-225)	RS - 2 (110-160)
RC - 3000 (215-290)	RS - 2K (75-130)
MC - 250 (140-225)	RS - 3K (110-160)
MC - 800 (175-225)	SS - 1 (75-130)
MC - 3000 (215-290)	SS - 1h (75-130)
	SS - K (75-130)
	SS - Kh (75-130)

2.2 Bituminous Additive. Additive shall be used when shown on Drawings.

2.3 Cover Aggregate. Cover aggregate (chips) shall be screenings of crushed slag, stone, or gravel which is free of dirt, clay balls, vegetable matter, and other deleterious substances. They shall consist of clean, sound, tough, durable particles of uniform quality.

The composite material shall be evenly graded and shall be within the limits of the following grading requirements for the grading shown on Drawings.

Percentage by weight passing square mesh sieves as determined by AASHO T-11 and T-27.

<u>Sieve Designation</u>	<u>Grading X</u>	<u>Grading Y</u>	<u>Grading Z</u>
3/4 inch	100		
1/2 inch	90-100	100	
3/8 inch	40-75	90-100	100
No. 4	0-15	10-30	75-100
No. 10	0-5	0-8	0-10
No. 200	0-2	0-2	0-2

The aggregate (chips) shall further conform to the following requirements as determined by the listed AASHO test designation.

Unit Weight-Loose	AASHO T-19	Not less than 80 lbs. pcf.
Percent of wear	AASHO T-96	Not more than 40
Soundness	AASHO T-104	Not more than 10, total sample 5 cycle, Sodium Sulfate
Stripping Test	AASHO T-182	Minimum 95 percent coated

Not less than 70 percent of the material retained on the No. 4 sieve shall be particles having at least one fractured face.

Blotter material shall be clean sand or other fine granular material.

Construction Methods

3.1 Weather and Temperature Limitations. Seal coat shall be applied only when the surface to be treated is dry to slightly damp or when the temperature of the road surface is 70°F., or more, and when the weather is not foggy or rainy.

3.2 Equipment. Operator shall provide, when necessary, equipment for brooming, cleaning or flushing, a bituminous material distributor, and equipment for heating, aggregate spreading equipment, and self-propelled pneumatic-tired roller.

The bituminous material distributor shall be self-powered and mounted on pneumatic tires. It shall be equipped with a pump and a full circulating

spray bar which is fully adjustable. The unit shall include a tachometer, pressure gages, accurate volume measuring devices such as visual volume dial or gage calibrated to the tank, and tank thermometer.

3.3 Cleaning Existing Surface. Prior to placing the seal coat, all blotter material, dirt, and other objectionable material shall be removed from the existing surface. The surface shall be cleaned with a power broom and/or power blower.

3.4 Application of Bituminous Material. The bituminous material shall be applied at the rate shown on Drawings so that a uniform distribution is obtained at all points. The material shall be applied within the temperature range stated in the specification for the particular material being used. When heating is required, suitable precaution shall be taken to avoid fire.

The surfaces of structures and trees adjacent to the area being treated shall be protected in such a manner as to prevent their being spattered or marred. Bituminous material shall not be discharged into borrow pits or gutters.

When necessary to provide for traffic, the bituminous material shall be applied in lanes of approximately one-half the width of the completed surface, if practicable. Under no conditions shall traffic be allowed to travel over a freshly sprayed surface. Under no conditions shall traffic be forced to travel over a freshly sealed surface. If detours cannot be provided and the road must remain open to traffic, Operator shall restrict his operation to a width which will permit at least one-way traffic over the remaining portion of the road. If one-way traffic is provided, it shall be controlled by flagging or pilot-car operation so as to adequately protect the traveling public and the work.

3.5 Seal Coat, Bituminous Only. The bituminous material shall be allowed to penetrate and cure undisturbed for a period of not less than 24 hours. Spots of excess bituminous material remaining at the end of the curing period shall be lightly covered with sand or other approved blotter material before the road is opened to traffic.

3.6 Seal Coat with Cover Aggregate. Before the bituminous material is applied, sufficient aggregate to cover the distributor load of bitumen shall be in trucks or stockpiled at the site of the work. Trucks hauling or spreading aggregate shall be operated so that bitumen will be covered before truck wheels pass over it.

Cover aggregate shall be uniformly spread, at the rates shown on Drawings within 5 minutes after application of the bitumen. If necessary to obtain uniform spreading, the cover aggregate shall be handbroomed.

The cover aggregate shall then be rolled with a pneumatic-tired roller until the chips are uniformly and thoroughly embedded and bonded over the entire

surface. Two complete rollings shall be considered as a minimum. Initial breakdown rolling shall be accomplished within 15 minutes after application of the bitumen, and all rolling shall be completed within two hours.

To prevent lapping at an end junction of two applications, building paper or other material shall be spread over the treated section to allow the distributor to be operating at full force and speed when reaching the untreated section.

Operator shall furnish a pilot car or otherwise conduct traffic over the completed chip course at a maximum speed of 15 miles per hour for the first 24 hours after cover aggregate is applied.

Operator shall maintain the seal course for a period of 5 days. Maintenance shall include light brooming or the addition of chips or blotter material to absorb any free bituminous material and rolling areas where there are indications of a lack of surface tightness. Care shall be taken in maintenance to prevent disturbance of aggregate in contact with bituminous material.

SPECIFICATION 65 - ROAD MIX, BITUMINOUS SURFACING

Description

1.1 This work shall consist of constructing Surface Course composed of aggregate and bituminous material, either mixed in place, mixed in a central plant, or platform mixed, then spread and compacted on the prepared roadbed or area in accordance with these specifications and in reasonably close conformity with the lines, grades, and dimensions shown on Drawings.

The percentage of bituminous material, by weight, to be added to the aggregate will generally vary between 3, 5, and 7 percent of the weight of the dry aggregate. The exact percentage to be used shall be determined by Forest Service on the basis of laboratory tests and sieve analysis of the aggregate furnished. The job-mix formula for each mixture shall be furnished by Forest Service.

Materials

2.1 Aggregate. Aggregate shall be of uniform quality, crushed to size as necessary, and shall be composed of hard pebbles or fragments of rock with a filler of finely crushed stone, sand, or other finely divided mineral aggregate.

The composite material shall be well graded from coarse to fine and shall be within the limits of the following grading requirements, as determined by AASHO T-11 and T-27, or as otherwise shown on Drawings.

<u>Sieve Designation</u>	<u>Percentage by Weight Passing Square Mesh Sieves</u>
1 inch	100
3/4 inch	84-100
No. 4	40-60
No. 8	25-45
No. 50	7-23
No. 200	2-10

The aggregate shall further conform to the requirements of the following tests:

Unit Weight	AASHO T-19	Not less than 80 lbs. pcf., loose
Liquid Limit	AASHO T-89	Not more than 30
Plastic Index	AASHO T-91	Not more than 6
Percent of Wear	AASHO T-96	Not more than 40
Swell	AASHO T-101	Method A, not more than 0.030" Method B, not more than 0.062"
Soundness	AASHO T-104	Not more than 12, total sample 5 cycles, sodium sulfate
Stripping Test	AASHO T-182	Not less than 95 percent coated

Not less than 50 percent of the material retained on the No. 4 sieve shall be particles having at least one fractured face.

Any material having a plasticity index shall have a dust ratio less than 55 percent. The dust ratio is the ratio of the amount of material passing the No. 200 sieve to the amount passing the No. 50 sieve.

The composite aggregate shall be free of vegetable matter, balls or adherent films of clay, or other matter which will prevent thorough coating with bituminous material.

2.2 Bituminous Material. Bituminous material shall be of the type and grade specified on Drawings or shall conform to the requirements of the specifications listed below:

Medium-Curing (MC) and Slow-Curing (SC) Liquid Asphalt:
AASHTO Specifications, Designation M-81, M-82, and M-141

Central or traveling mixer mixing temperatures (in degrees F.) will be as follows:

MC-250 (125-200)	SC-250 (125-200)
MC-800 (160-225)	SC-800 (160-225)
MC-3000 (200-260)	

Mixed in place or platform mixed distributor temperatures (in degrees F.) shall be as follows:

MC-250 (140-225)	SC-250 (140-225)
MC-800 (175-225)	SC-800 (175-225)
MC-3000 (215-290)	

2.3 Bituminous Additive. Additive shall be used when shown on Drawings.

Construction Methods

3.1 Weather and Temperature Limitations. Bituminous material will be applied only when the atmospheric temperature in the shade is above 55°F., and rising; or above 60°F., if falling; and when the weather is not foggy or rainy, or excessively windy.

Bituminous material shall not be applied to or mixed with aggregate which has greater than 3 percent moisture by weight.

3.2 Equipment. Operator shall provide sufficient equipment for windrowing and spreading aggregate; a pressure bituminous material distributor and blade graders for mixing, or a traveling mixing plant or a stationary mixing plant and hauling equipment; spreading, finishing, and compacting equipment; and equipment for heating bituminous material when necessary. Compaction equipment shall be self-propelled.

The asphalt distributor shall be self-powered and mounted on pneumatic tires. It shall be equipped with a pump and a full-circulating spray bar which is fully adjustable. The unit shall include a tachometer, pressure gages, heating device, accurate volume-measuring devices, such as a visual volume dial or gage calibrated to the tank, and a tank thermometer.

The traveling mixing plant shall be a twin-shaft pugmill pneumatic, mounted with sufficient controls for prevention of damage to the prepared base. It shall be capable of picking up all the loose material in the aggregate windrow and accurately adding the required amount of bituminous material. The equipment shall include an accurate asphalt volume-metering device or calibrated tank and a tank thermometer.

A stationary mixing plant shall contain at least the following features: Bituminous storage tank with adequate heating equipment, and devices to add and control the rate of application of bitumen; storage bins for aggregate with accurate weighing or measuring devices, and a twin-shaft pugmill mixer.

All equipment shall be standard, modern, commercial types of proven performance.

3.3 Preparation of Base. When a prime coat of bituminous material is called for in Drawings, it shall be applied and maintained in accordance with Specification No. 61, "Bituminous Prime Coat."

When a prime coat is not called for, the existing roadway shall be prepared as specified under Specification No. 50, "Crushed Aggregate Base," or Specification No. 62, "Bituminous Treated Base."

3.4 Spreading Aggregate, Windrowing and Sampling. When either travel plant or blade grader mixing is to be used, the aggregate shall be placed in a uniform windrow on the prepared base by use of an approved machine. Care shall be exercised so that no base or shoulder material is mixed with the surfacing aggregate.

The aggregate windrows shall be of uniform section and shall contain the correct quantity to provide surfacing of the required width and compacted thickness. Windrows shall be left undisturbed until quality acceptance sampling is completed.

Just prior to adding bituminous material, the aggregate shall be tested for moisture. If the moisture content is more than 3 percent, the aggregate shall be turned or otherwise aerated until the moisture content is reduced to 3 percent or less.

3.5 Travel Plant Mixing. The aggregate windrows shall be of such size that the rated capacity of the travel plant will not be exceeded.

The plant shall not be operated in excess of its rated speed and capacity and bitumen shall be introduced at the designated rate and within the specified temperature range.

Mixing shall continue until the bitumen is uniformly distributed throughout the mass and the aggregate particles are uniformly and completely coated. After approval, the mixture shall be spread to the required width and thickness shown on Drawings.

3.6 Blade Grader Mixing. The aggregate windrows shall be spread to the minimum width necessary for application of the bituminous material. The bitumen shall be sprayed or applied at the rate and temperature within the specified range. The method of application shall be such that no liquid bitumen will be allowed to flow onto the prepared base. During all applications, the surfaces of adjacent structures and trees shall be protected to prevent their being spattered or marred.

Mixing shall begin immediately following the application of the bitumen, and shall continue until the bitumen is uniformly distributed throughout the mass, and the aggregate particles are uniformly and completely coated.

At the end of each day's work, or whenever operations are interrupted, all loose material shall be bladed into a windrow, whether the mixing is complete or not, and be retained in a windrow until operations can be resumed. No bitumen shall be wasted or discharged except where authorized.

After the mixture has been approved, it shall be spread and compacted to the required width and thickness shown on Drawings.

3.7 Central Plant Mixing. The specified quantities of aggregate and bituminous material in the specified temperature range shall be mixed in the pugmill to obtain a uniform mixture with the aggregate particles completely covered.

The mixture shall be placed on the prepared subgrade in a uniform layer of the required width and thickness shown on Drawings. Spreading may be done with a windrow sizer and spread by patrol or with a paving machine, or with a spreader box.

3.8 Platform Mixing. Platform mixing may be done with either a travel plant or blade graders. The platform shall be at least 1,000 feet long and windrows shall be of a size so that complete mixing can be attained before the dilutant leaves the bitumen.

After the mixture has been approved, it shall be bladed into a tight windrow. When loading the mixture, care shall be exercised not to pick up untreated material from the platform.

Platform-mixed material may be transported and laid in the same manner as central plant mixture.

3.9 Compacting and Finishing. After the mixture is spread, the surface shall be rolled. Rolling shall be longitudinal and shall commence at the outer edges of the road, overlapping the shoulders, and progress toward the center, overlapping the previous pass by one-half the width of the roller. Rolling shall continue until the surface is of uniform texture and degree of compaction. Not less than two complete coverages shall be made. Under no condition shall the center of the surface be rolled first. Initial rolling shall be performed with a pneumatic-tired roller and final rolling with a smooth steel wheel roller. Vibratory-type compaction equipment of these types may be used.

Finished shoulder and other lines shall be true and present a workmanlike appearance.

The thickness of completed pavement, when central plant or platform mixing is used, shall not vary from the specified thickness by more than $\frac{1}{4}$ inch. Measurement taken before and after compaction will establish control of thickness.

3.10 Surface Requirements. The completed surfacing, when ready for acceptance, shall be thoroughly compacted, smooth and true to grade and cross section. When tested, using a cross-section template applied at right angles to the centerline, the surface shall at no point exceed $\frac{1}{2}$ -inch variation from any two points of contact. When tested, using a 10-foot straightedge, applied parallel to the centerline at any point, the surface shall at no point exceed $\frac{1}{4}$ -inch variation from any two points of contact.

Tests for conformity with the specified crown and grade shall be made immediately after initial compaction, and variations corrected in an approved manner.

3.11 Stockpiling. When called for on Drawings, road mix aggregate and/or bituminized mixture shall be stockpiled in the amounts and on satisfactory stockpile sites at the locations indicated.

3.13 Seal Coat. The road mix surface shall be opened to traffic for at least 2 weeks, or until the dilutent has evaporated from the material, before any seal coat is applied.

SPECIFICATION 70 - TREATED TIMBER STRUCTURES

Description

1.1 This work shall consist of timber structures and timber portions of composite structures constructed in conformity with the lines, grades, dimensions, and designs shown on Drawings and in accordance with these specifications. It shall include all hardware and the furnishing, fabricating, pressure treating, and erecting the lumber and timbers called for on Drawings.

This work also shall include all the necessary excavation for cribbing, headwalls, riprap, foundations for bridges, piers, and abutments, including the work of draining, pumping, bailing, sheeting, shoring, construction and removal of cribs and cofferdams, backfilling, compacting, sloping, disposing of surplus or unsuitable material and cleaning up the site, all in accordance with these specifications and in conformity with Drawings.

Materials

2.1 All timber, lumber, and piling shall be of the species, grades, and finishes shown on Drawings, and all fabrication shown on Drawings shall be done accurately before preservative treatment is applied.

2.2 Preservative Treatment. All timbers, lumber, and piling shall be treated in accordance with the requirements of AASHO M-133, or as otherwise specified on Drawings.

2.3 Certification. When required to furnish materials, operator shall furnish to Forest Service the supplier's certifications that all wood materials, including structural glue-laminated members, meet the requirements for species, grades, and preservative treatments before any timber or lumber is placed in the work.

2.4 Hardware and Structural Steel. All hardware and structural steel shall be of the sizes, shapes, types, and finishes for specific uses, as shown on Drawings. All structural steel shapes, plates, and bars shall conform to the requirements of ASTM-A36, unless otherwise specified. Any variations in materials or uses must be agreed to. Unless otherwise shown on Drawings, all hardware and structural steel shall be galvanized in conformity with ASTM-A153 and ASTM-A123, respectively.

2.5 Deck Surfacing. Aggregates shall meet the grading requirements shown on Drawings.

2.6 Structural Glue-Laminated Timber. All lumber shall be graded in accordance with the current standard grading rules as shown on Drawings. The fabrication and quality controls shall be in accordance with the requirements of the current edition of "U.S. Commercial Standards, CS-253, Structural Glue-Laminated Timber." Unless otherwise shown on Drawings, the members shall be manufactured as "Industrial Appearance Grade" for wet conditions use. When required to furnish laminated members, operator shall provide a certificate of conformance with specifications furnished by AITC, or an independent testing laboratory.

Construction Requirements

3.1 All necessary clearing and grubbing shall be completed prior to starting the excavation operations.

3.2 The excavation shall be made to the elevations and dimensions as established on Drawings. Where a firm foundation is not encountered due to soft or other unstable soil, the unsuitable soil shall be removed to a suitable elevation and backfilled with gravel or other suitable material.

Rock or other hard materials used as foundation for masonry or concrete shall be freed and cut to a firm surface, either level, stepped, or serrated and cleaned free of all loose material. Cofferdams or cribs for foundation construction shall, in general, be carried well below the bottoms of the footings and shall be well placed and as nearly watertight as practicable. In general, the interior dimensions of cofferdams shall be such as to give sufficient room for the construction and inspection of forms and to permit pumping. Cofferdams or cribs which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance. No structure shall be placed until the foundation has been approved by Forest Service. Suitable surplus excavated materials shall be used in the construction of embankments or disposed of as shown on Drawings, and unsuitable materials shall be wasted in agreed areas. Material removed below designated elevations shall be replaced with approved materials.

3.3 Backfilling. No backfill shall be placed without the approval of Forest Service. The excavated areas around the structure shall be back-filled in horizontal layers not over 6 inches thick and shall be thoroughly compacted. Placement of backfill shall not be by hydraulic methods. No backfill shall be placed against concrete until the concrete has cured 14 days or until field cured test cylinders show the strength to be twice the working stress used in the design. Wedging action against wall or abutments shall be prevented by stepping or serrating sloping surfaces of excavation. Where material from structural excavation is unsuitable for backfilling purposes,

or if the backfill quantities required are in excess of the structural excavation quantities, operator will be required to furnish and place materials suitable for this purpose. Backfilling of structures shall not proceed until the stringers are in place and shall proceed upward simultaneously at each end of the structure. Adequate provision shall be made for thorough drainage of the backfill. Broken rock or gravel shall be provided to construct drains and weep holes as shown on Drawings. No stones or rocks larger than 3 inches in the largest dimension shall be placed closer than 12 inches to the structure. Excavated material other than that being placed as backfill or approach fills shall not be deposited in stream courses or lakes.

3.4 Storage and Handling of Material. All materials shall be handled, stacked, and protected so as to prevent scarring, breaking, warping, or weathering. No cant dogs, hooks, pike poles, or peavies will be permitted, and construction timber shall not be dropped, marred, or broken. Corners of heavy construction timbers and banded packages of lighter construction timber shall be protected when handled by slings. All field fabrication cuts or abrasions made in construction timber or piling, after treatment, shall be carefully trimmed, given two coats of hot creosote oil, and covered with one coat of hot roofing pitch.

3.5 Workmanship. All lumber and construction timber shall be cut and framed so that all joints will have even bearing over the entire contact surface. No shimming shall be done in making joints and all joints shall be closed. Nails and spikes shall be driven with just sufficient force to set the head flush with the wood surface. All field drilled holes for machine bolts shall be drilled 1/16 inch larger in diameter than the bolt. All field drilled holes for smooth dowels and drift pins shall be 1/16 inch less in diameter than the dowels or pins. Holes for lag screws shall have the same diameter and depth as the shank of the screw, plus a lead hole for the threaded portion with a diameter approximately 75 percent of the shank diameter. Before driving bolts or pins, all holes bored after treatment shall be impregnated with hot creosote oil by means of an approved bolt hole treatment. Any holes drilled but not used after being treated with creosote oil shall be plugged with creosote-treated plugs.

3.6 Bolts and Washers. Washers of the size and type shown on Drawings shall be placed under all bolt heads and nuts. All nuts shall be finally tightened to provide proper bearing and excess bolt lengths of more than 1 inch shall be cut off. After being finally tightened, all nuts shall be checked or burred effectively with a pointing tool to prevent loosening.

3.7 Framed Bents. Mud sills shall be firmly and evenly bedded to solid bearing and carefully tamped in place. Concrete pedestals for the support of framed bents shall be finished carefully so that sills or posts will bear evenly and uniformly over the entire bearing surface. Anchoring bolts or dowels shall be set as indicated on Drawings.

3.8 Pile Bents. Treatment, furnishing, and driving of construction piles shall be in accordance with Specification 73 - "Construction Piling."

3.9 Caps for all Bents. Timber caps shall be placed to obtain even and uniform bearing over the tops of all supporting construction posts or construction piles. All caps shall be secured as indicated on Drawings and ends of caps shall be in true alignment.

3.10 Bracing. Bracing shall be bolted through at intersections with the construction piling and construction posts, and capped or sealed as indicated on Drawings.

3.11 Stringers. Stringers shall be size matched at bearings and shall be positioned so that the camber is up and, if possible, so that knots near the edge will be in the top portion of the stringers. Bridging between stringers shall be neatly and accurately framed and securely toenailed. All stringers shall be securely fastened to caps as indicated on Drawings.

3.12 Laminated Floor. Pieces for laminated floors shall be of the finish and nominal dimension as indicated on Drawings. Pieces shall be laid to obtain the most uniform bearing on stringers. Pieces shall be fastened to stringers and adjacent pieces in accordance with the nailing schedule, as indicated on Drawings. Pieces with minor variation in thickness shall be spaced so as to keep the pieces vertical and at right angles to stringers.

3.13 Cleanup. Upon completion and before final acceptance, operator shall remove all excavated or unused materials, rubbish, temporary buildings, and all false-work construction piling down to 2 feet below the finished ground line or water line. He shall replace or renew any fences damaged and shall leave the bridge site and adjacent roadway in a neat and presentable condition. All excavated material or false-work placed in the stream channel during construction shall be removed.

SPECIFICATION 72 - CATTLEGUARDS

Description

1.1 This work shall consist of constructing cattleguards, connecting fences, and gates constructed in accordance with these specifications and Drawings at the location and in conformity with the lines and grades shown on Drawings or as established on the ground. This item shall also include the excavation, bedding, and backfilling for the cattleguard foundation.

Materials

2.1 The materials shall conform to the kind, grade, type, and size specified on Drawings. They shall also conform to Specification 70 - "Treated Timber Structures," and Specification 75 - "Fences and Gates."

Construction Methods

3.1 Grading shall be completed at the location of the cattleguard before excavation for the cattleguard is started.

When unstable foundation soil is encountered, it shall be removed to a suitable elevation and the excavation backfilled with gravel or other suitable material.

After the structure is assembled, the surrounding areas shall be backfilled with approved material, placed in horizontal layers not over 12 inches in depth, and thoroughly compacted to the grade level called for on Drawings or staked on the ground.

Fill shall be deposited uniformly on both sides of the structure at the same time. Proper precautions shall be taken to assure that the method of operation used in backfill construction does not cause movement or undue strain on the structure.

The cattleguards and connecting fences and gates shall be assembled and placed as shown on Drawings.

SPECIFICATION 73 - METAL BIN-TYPE RETAINING WALL

Description

1.1 This work shall consist of installing metal bin-type retaining wall at the designated locations in accordance with these specifications, and in conformity with the lines, grades, and dimensions shown on Drawings and as staked on the ground.

Materials

2.1 The base metal and spelter coating shall meet the requirements of Federal Specification WW-P-402B or WW-P-405a.

2.2 Manufacture. Metal bin-type retaining walls shall consist of pairs of columns, one column of each pair being in the plane of the front and the other column being in the plane of the rear of the wall, with the pairs of columns spaced longitudinally with overlapping S-shaped facing and rear members (stringers) and transversely with overlapping U-shaped tie members (spacers). The necessary bolts and appurtenances shall be furnished for complete assembly of the units into a continuous closed face wall of connected bins.

The wall members shall be constructed of metal of the thickness shown on Drawings. In forming the units, a minimum forming radius of 1 inch should be maintained, but if units are formed with less than 1 inch radius, they shall be hot-dipped galvanized after forming.

All units shall be fabricated so that units of the same nominal size shall be fully interchangeable. No field drilling, punching, or drifting to correct defects in manufacture shall be permitted. Any units having holes improperly punched shall be rejected.

The ends of all stringers and spacers shall be bolted to corner columns by means of connecting channels, thus transmitting the load to the corner columns.

In the construction of a wall on a curve, the proper curvature for the face shall be obtained by the use of variable lengths of stringers as designated on Drawings.

Construction Requirements

3.1 Foundation Excavation. Rough excavation for the site of the wall shall be made to the elevation of the finished ground line at the face of the wall. Below this point, trenches approximately 18 inches in width shall be excavated for the four sides of the bin. The bearing at the corners of the bin shall be firm at construction grade.

3.2 Erection-Assembly. The units shall be erected in accordance with the assembly diagrams furnished by the manufacturer. Members shall be handled carefully, and any which are damaged shall be removed. After assembling, all bolts shall be drawn tight before beginning the backfill.

3.3 Backfilling. The filling for the interior of the bins and behind the wall shall be of approved material placed in layers not to exceed 6 inches in thickness and shall be tamped or consolidated. All vegetable matter and unstable soil shall be excluded from the backfill, and the pudding method of backfilling shall not be used. Backfilling behind the wall shall not precede filling of the bins. Existing slopes which might cause a wedge action in the backfill shall be step-cut or benched before backfilling.

Select material for backfill shall be provided from roadway excavation or borrow.

SPECIFICATION 75 - FENCES AND GATES

Description

1.1 This work shall consist of furnishing and erecting fence and gates in accordance with these specifications and in conformity with the lines shown on Drawings.

Materials

2.1 The materials used shall be of the kind, grades, sizes, and type specified on Drawings and shall include the necessary fittings.

2.2 Barbed Wire. Barbed wire shall conform to the requirements of ASTM A126.

2.3 Woven Wire. Woven wire shall conform to the requirements of ASTM A118.

2.4 Chain Link Fabric. Chain link fabric and required fittings and hardware shall conform to the requirements of AASHO M-181, for the kind of metal, coating, sizes of wire, and mesh specified.

2.5 Timber Rail. The timber rail shall be cut from the specified grade of dry, well-seasoned and dressed timber stock of the species specified on Drawings, and shall meet the applicable requirements of AASHO M-168.

Where preservative treatment is specified on Drawings, it shall conform to the requirements of AASHO M-133.

2.6 Fence Posts. Wood posts shall conform to the details and dimensions indicated on Drawings. All wood posts shall be of sound, seasoned wood, peeled or sawn and with ends cut square or as indicated. The posts shall be straight and all knots trimmed flush with the surface. Where treated posts are called for, the kind and type of treatment shall conform to that indicated on Drawings.

All dimension timber and lumber required for fences or gates shall be sound, straight, and free from loose knots, splits, and shakes. It shall be of the species and grades indicated on Drawings and shall be dressed and finished on four sides.

Concrete posts shall be made of concrete of the class specified, and shall contain steel reinforcement as shown on Drawings.

Metal fence posts shall meet the requirements of Commercial Standard No. 184-51, Steel Fence Posts. Line type posts shall weigh not less than 1.33 pounds per linear foot. Punched tab type posts shall not be used.

Construction Methods

3.1 Trees, brush, and other obstacles along the fence line shall be removed. Materials so removed shall be disposed of in accordance with the requirements for "Clearing and Grubbing," as shown on Drawings.

3.2 All old fencing that is to be removed shall be dismantled and salvaged or disposed of.

3.3 Continuous grading along the fence line is not allowed. In general, the fence shall be erected on the undisturbed natural ground.

3.4 Posts shall be set plumb and to the spacing and depth shown on Drawing, backfilled, and firmly tamped. After the posts are set, the wire fencing shall be stretched and fastened to wooden posts with staples or to steel posts with wire clamps. Concrete for post bases and braces, when required by Drawings, shall be according to Specification for "Portland Cement Concrete," or as shown on Drawings, and the tops of concrete sections shall be crowned to drain. All posts for chain link fence shall be placed in concrete.

Changes in line where the angle of deflection is 30 degrees or more shall be considered as a corner and a corner brace shall be installed. Intersecting fences shall be terminated as shown on Drawings.

When drilling into rock is required to set a post, operator may shorten the posts, provided a minimum length of 12 inches of post is grouted into the rock.

At grading depressions, where stresses tend to pull posts from the ground, sag bracing shall be installed as shown on Drawings. If it is necessary to cut and splice woven wire fence to accommodate the grade change, the splice shall be made at a line post or an additional post shall be installed at the splice. Wire splices in barbed wire will be permitted if made with an approved bolt clamp splice, or with a "Western Union" splice of at least six turns per end.

Where the fence crosses small streams, gullies, or ground depressions between adjacent posts, an additional wire or wires shall be placed below the normal fencing to close the opening and maintain uniform distance above the ground. These wires shall be anchored.

Air temperature shall be considered when stretching wire. In very cold weather, the wire shall be stretched very tightly. Woven wire shall not be stretched so tightly that the preformed kinks in the horizontal wires are straightened. Intersecting fences shall be braced at the intersection with a terminal brace as shown on Drawings.

3.5 Grounding Chain-Link Fence. If chain-link fence is built parallel to a powerline, it shall be grounded at posts not less than every 300 feet or at each brace.

3.6 Gates. Specified rigid gates shall be hung and adjusted with care to ensure that they are level in all positions and so that the latches will operate easily and firmly. When loose wire gates are specified, they shall be constructed and installed as shown on Drawings.

SPECIFICATION 77 - PLANTING AND SEEDING

Description

1.1 This work shall consist of seeding, mulching, conditioning, and fertilizing all areas at locations and in accordance with the treatment specified on Drawings.

Materials

2.1 Materials shall meet the requirements specified below.

2.2 Agricultural Limestone. Agricultural limestone shall be a calcitic or dolomitic ground limestone containing not less than _____ percent of total calcium and magnesium carbonates. Limestone shall conform to the standards of the Association of Official Agricultural Chemists and shall comply with all existing State and Federal regulations. Rates of application shall be shown on Drawings, or in the Special Provisions. Limestone shall meet the following sieve analysis: At least 40 percent passing a number 100 sieve and at least 95 percent passing a number 8 sieve. Other agricultural lime materials may be used as specified.

2.3 Fertilizer. Fertilizer shall be a standard commercial grade fertilizer and shall conform to all State and Federal regulations and to the standards of the Association of Official Agricultural Chemists. Commercial fertilizer shall provide the minimum percentage of available nutrients as specified. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked.

2.4 Seed. Seed shall be furnished in mixture in standard containers with: (1) seed name; (2) lot number; (3) net weight; (4) percentage of purity, and germination, and hard seed; and (5) percentage of maximum weed seed content clearly marked for each kind of seed. Operator shall furnish Forest Service duplicate signed copies of statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within 6 months of date of delivery. This statement shall include: (1) name and address of the laboratory; (2) date of test; (3) lot number for each kind of seed, and; (4) results of tests as to name, percentages of purity, and of germination and percentage of weed content for each kind of seed furnished and in case of a mixture, the portion of each kind of seed.

2.5 Water. Water used in planting or care of vegetation shall be free from oil, acids, alkalis, salts, or any substance injurious to plant life. Water from streams, lakes, ponds, or similar sources shall not be used unless approved by Forest Service.

2.6 Mulch

- a. Wood Chips. Wood chips shall be obtained from disease-free green hardwood, shall be 1/8-inch nominal thickness with 50 percent having an area of not less than 1 square inch nor more than 6 square inches. All wood-chip mulch shall be free from leaves, twigs, shavings, bark, or material injurious to plant growth.
- b. Straw. Straw for mulching shall be from oats, wheat, rye, clover, or other approved crops which are free from noxious weeds, mold, or other objectionable material. Straw mulch shall be in an air-dried condition and suitable for placing with mulch blower equipment.
- c. Hay. Hay shall be of approved herbaceous mowings free from noxious weeds, mold, or other objectionable material. Hay shall be in an air-dried condition and suitable for placing with mulch blower equipment.
- d. Wood Cellulose Fiber. Natural wood cellulose fiber shall have the property of dispersing readily in water and shall have no toxic effect when combined with seed or other materials. The homogenous slurry or mixture shall be capable of application with power spray equipment. A colored dye which is non-injurious to plant growth shall be used when specified. Wood cellulose fiber shall be packaged in new label containers in an air-dry condition and have a pH of 8.5 to 10 in distilled water.
- e. Sawdust. Sawdust shall be obtained from wood which has not been subjected to conditions which would cause the sawdust to lose its value or usefulness as a mulch. Sawdust shall not contain any toxic substances.
- f. Peat Moss. Peat Moss shall be provided in bales. Peat moss shall be granulated, reasonably free from partially decomposed woody substances. The peat moss may vary from porous fibrous to spongy fibrous and shall be free of sticks, stones, and mineral matter.

Peat moss shall be in an air-dried condition, shall show an acid reaction of 3.5 pH to 5.5 pH and shall otherwise conform to State and Federal regulations.

- g. Peat Humus. Peat humus shall be a natural peat or peat humus from fresh water saturated areas consisting of sedge, sphagnum, or reed peat and be of such physical condition that it will pass through a ½-inch mesh screen. The humus shall be free from sticks, stones, roots, and other objectionable materials. Samples taken at the source of supply shall have the following analysis:

Acidity Range - 4.0 to 7.5 pH

Minimum water-absorbing ability - 200 percent by weight
on oven dry basis

Minimum Organic Content - 60 percent when dried at 105°C.

Freshly excavated peat, if saturated with water, shall be stored for a sufficient length of time to condition it for workability.

2.7 Emulsified Asphalt. Emulsified asphalt for use with straw or hay mulch shall be applied to the mulch material at the rate per acre as shown on Drawings. Emulsified asphalt shall be SS-1 or equivalent.

2.8 Burlap. Burlap shall be of standard weave with a weight of 3.5 to 5.0 ounces per square yard.

2.9 Jute Mesh. Jute mesh shall be of the type specified on Drawings.

2.10 Woven Paper or Sisal Mesh Netting. Woven paper or woven sisal mesh netting shall be woven from twisted yarns available in rolls 45 to 48 inches wide. Mesh may vary from close to open weave ranging from 1/8- to 1/4-inch openings. Shrinkage after wetting shall not exceed 20 percent of the surface area.

Construction Requirements

3.1 Seasonal Limitations. Normally, the work shall be performed on prepared seedbeds during the spring or fall planting seasons--depending on site, weather, soil conditions, etc. The work shall be performed only at times when weather and other conditions at the site are favorable. No work will be performed when the wind conditions prohibit uniform distribution of seed, or when the ground is frozen or snow covered.

Within the limits herein set forth, the work may be done in stages along the road, as slopes are finished, or it may be done as a whole. In either case, operator is responsible for maintenance and protection of the seeded areas until the job is accepted.

3.2 Advance Preparation and Cleanup. After grading is completed and before applying revegetative measures, areas to be revegetated shall be raked or otherwise cleared of sticks, stumps, stones larger than 2 inches in any diameter, and other debris which might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes occurs after the completion of grading and before beginning the revegetation work, operator shall repair such damage. This shall include filling gullies, smoothing irregularities, and repairing other incidental damage. Immediately in advance of the seeding, any crusted surface shall be scarified at right angles to the slope plane.

3.3 Seeding. Seeding shall be sown at the rate per acre specified in Section 3.8 and only during the periods specified in the Supplemental

Specifications. Seed may be sown with seed drills, rotary hand seeders, power sprayers, or blowers. Seeding shall not be done during windy weather or when the ground is excessively wet or frozen. Seed shall be sown immediately following the application of fertilizer and/or ground limestone, as required, except in those cases where seed and fertilizer are combined and applied in one operation.

3.4 Fertilizing. Following advance preparation and cleanup, and topsoiling, if required, fertilizer shall be uniformly spread at the rate specified. If an application of ground limestone is required, it shall be spread at the rate specified before the area is scarified.

Approved mechanical spreaders shall be used for spreading fertilizer and ground limestone, except that on steep slopes where fertilizer and ground limestone cannot be incorporated effectively by mechanical equipment, they may be applied by any approved method and need not be incorporated into the soil. Fertilizer and seed may be applied in one operation by approved power sprayer or blower equipment.

3.5 Water. Water shall be used in the amounts necessary to spread the seed, fertilizer, and mulch by the approved methods and at the specified rates.

3.6 Mulching. If mulching is specified, the seeded area shall be covered with mulch within 24 hours from the time seeding has been completed. If excessive rain or other weather conditions require additional delay, areas may require additional treatment to replace lost materials. The mulch shall be spread uniformly at the locations shown on Drawings and at the rate of application specified in Section 3.8. It may be spread by hand, by a blower, or by other equipment. The mulch shall be treated by light discing, by covering with brush, by covering thinly with soil, by staking and tying, by spraying with asphaltic material, or by other methods shown on Drawings.

3.6 Maintenance of Seeded and Mulched Areas. Surfaces gullied or otherwise damaged following seeding and mulching, shall be repaired by regrading, reseeding, and remulching as directed, and otherwise to maintain the areas in a satisfactory condition until final inspections and acceptance of the work.

3.7 Holding Agents. Holding agents such as jute matting shall be placed in accordance with manufacturer's recommendations or as approved by Forest Service. The holding agent shall be installed so as to completely cover the specified seeded area.

Specifications

3.8 Seed. Seed shall be of the types and percents as listed below and applied at _____ pounds per acre.

Species	% Mixture	Pure Live Seed	Poison and/or Repellent

3.9 Fertilizer. Fertilizer shall be of the type listed below and applied at _____ pounds per acre.

Type	% Nitrogen	Percent	Percent

3.10 Mulch. Mulching material shall be spread evenly at the rate of _____ pounds per acre.

SPECIFICATION 78 - MARKERS AND GUIDEPOSTS

Description

1.1 This item shall consist of maintenance marker posts, culvert marker post, and guideposts, furnished and installed in accordance with these Specifications and in conformity with the sizes, dimensions, designs, location, and spacing shown on Drawings.

Materials

2.1 Timber, metal material, preservative treatment, paint, and reflectors shall conform with the requirements shown on Drawings and the Supplementa Specifications.

Construction Requirements

3.1 Construction and fabrication of marker posts and guideposts shall be as shown on Drawings. Each post shall be set firmly in place at the required location and elevation, as staked on the ground.

SPECIFICATION 79 - CONSTRUCTION PILING

Description

1.1 This work shall consist of furnishing and driving construction piling in accordance with these specifications and at the locations shown on Drawings.

Materials

2.1 Treated and Untreated Timber Piling. Timber piling shall conform to the requirements of AASHO M-168.

2.2 Structural Steel Piling. Structural steel piling shall be rolled steel sections of the weight and shape called for on Drawings and shall meet the requirements of AASHO M-183, provided that where Supplemental Specifications call for copper-bearing steel, the steel shall contain not less than 0.20/100 percent nor more than 0.35/100 percent of copper. Steel manufactured by the "Acid Bessemer Process" shall not be used. Steel piling, when placed in the leads, shall not exceed the camber and sweep permitted by allowable mill tolerance. Bent or otherwise damaged steel piling will be rejected.

Construction Requirements

3.1 General. Piling shall not be driven until after the excavation is complete. Piling lengths shall be as shown on Drawings.

Unless otherwise directed, piling shall be driven to a minimum penetration shown on Drawings, regardless of whether the required bearing, as determined by the formula, is obtained.

If the required penetration cannot be obtained with a hammer having the highest energy rating permitted, drilling or jetting shall be done.

Piling shall be driven at the locations and to the spacings, batter, depths, and bearings shown on Drawings.

All piling pushed up by the driving of adjacent piling or by any other cause shall be redriven.

3.2 Caps and Collars. Before placing timber piling into the leads, the butt of the piling shall be cut off square and the edges of the freshly cut surface chamfered. The heads of timber piling shall be provided with metal caps, supporting timber shock blocks, or collars wrapped with wire to prevent splitting. For driving steel H-beams piling, and shells without a mandrel, for cast-in-place concrete piling, cast steel combination driving heads and pilots with suitable cushion blocks shall be used. The driving heads shall closely fit the top of the steel piling or shell and shall be of such design as has been proved satisfactory for the proper driving of the piling being used.

3.3 Pointing and Shoes. When specified on Drawings, the piling shall be shod with metal shoes. The point of the piling shall be carefully shaped to secure a uniform, even bearing on the shoe.

3.4 Gravity Hammers. Gravity hammers for driving piling shall weigh not less than 2,000 pounds. The drop of fall shall be so regulated as to avoid injury to the piling, and in no case shall exceed 15 feet for a 2,000-pound hammer and 10 feet for a 3,000-pound hammer.

3.5 Steam, Air or Diesel Hammers. Only steam, air, or diesel hammers shall be used for driving steel piling or shells. Steam and air hammers shall develop an energy per blow of not less than 6,600 foot pounds, nor more than 19,500 foot pounds. Diesel hammers shall develop a factory rated energy of not less than 9,100 foot pounds, nor more than 22,500 foot pounds. Steam and air hammers shall be operated at all times at the pressure and speed recommended by the manufacturer.

3.6 Timber and H-Beam Piling Bearing. In the absence of loading test, the safe bearing values shall be determined by the following equations:

$$P = \frac{2WH}{S+1.0} \quad \text{for gravity hammers}$$

$$P = \frac{2WH}{S+0.1} \quad \text{for single-acting steam hammers}$$

$$P = \frac{2H(W+AP)}{S+0.1} \quad \text{for double-acting steam hammers}$$

$$P = \frac{2E}{S+0.1} \quad \text{for diesel hammers}$$

Where P = safe bearing power in pounds

W = weight, in pounds, of striking parts of hammer

H = drop or stroke of hammer or ram in feet

A = area of piston in square inches

- P = steam pressure in pounds per square inch at the hammer
S = the average penetration in inches per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam, air, and diesel hammers.
E = rated striking energy of hammer in foot pounds.

The above equations are applicable only when:

- a. The hammer has a free fall.
- b. The head of the piling is not broomed or crushed
- c. The penetration is reasonably quick and uniform
- d. A follower is not being used.

Twice the height of the bounce shall be deducted from "H" to determine its value in the equation.

3.7 Splicing.

1. Timber Piling. Piling shall be spliced only when approved.

2. Metal Piling. When splices are made in metal piling, such splices shall be made by a continuous electric arc weld using approved methods and materials.

3.8 Followers. The driving of timber piling with followers shall be avoided, if practicable, and shall be done only with written permission. When followers are used, one piling from every group of ten shall be one driven without a follower, and shall be used as a test pile to determine the bearing power of the group.

3.9 Loading Tests. When required, the size and number of pilings shall be determined by actual loading tests. These tests shall consist of the application of a test load placed upon a suitable platform supported by the piling, with suitable apparatus for accurately measuring the test load and the settlement of the piling under each increment of load. The safe allowable load shall be considered as 50 percent of that load which, after a continuous application for 48 hours, produces a permanent settlement not greater than $\frac{1}{4}$ inch measured at the top of the piling. This maximum settlement shall not be increased by a continuous application of the test load for a period of 60 hours or longer.

3.10 Storage and Handling of Timber Piling. The method of storing and handling shall be such as to avoid damage to the piling. Special care shall be taken to avoid breaking the surface of treated timber piling. Cant dogs, hooks, or pike-poles shall not be used. Cuts or breaks in the surface of treated timber piling shall be given three brush coats of hot creosote oil of approved quality. Hot creosote oil shall be forced under pressure into all bolt holes drilled after treatment.

3.11 Cutting Piling. Timber piling driven to very nearly the cut-off elevation shall be carefully adzed or otherwise freed from all broomed, splintered, or injured material.

When pilings are fully driven, inspected, and approved, they shall be neatly cut on a horizontal plane at the cut-off elevations shown on Drawings and treated with two applications of hot creosote oil and covered with one coat of hot roofing pitch.

SPECIFICATION 80 - PORTLAND CEMENT CONCRETE

Description

1.1 This work shall consist of concrete composed of portland cement, fine aggregate, coarse aggregate, and water prepared and placed in accordance with these Specifications at the locations and to the form and dimensions shown in detail on Drawings.

1.2 Unless otherwise specified in the Supplemental Specifications:

a. All concrete shall be designed to develop a minimum compressive strength of 3,000 psi at 28 days when tested in accordance with ASTM C-39-68.

b. All concrete shall be air entrained.

c. Type I or II Portland cement shall be used unless otherwise specified on Drawings. Type III may be used when high early strength is required.

1.3 Composition of Concrete. The values given in Table I are master limits governing the proportions of the materials throughout the progress of the work. The design of the mix, or the exact proportions of cement, fine aggregate, coarse aggregate and water, will be the responsibility of Purchaser. The proposed mix design data will be submitted to Forest Service for approval 10 days prior to any concrete work.

Table I

Max. size coarse aggregate-inches	Min. cement content Bags per Cu. Yd.*	Max. water content, Gal. per Bag Cement	Percent air by volume
3/4"	6	6	5-7
1"	6	6	4-6
1-1/2"	5-1/2	6	3-1/2-5-1/2
2"	5	6	3-5

* Seal concrete shall contain an additional bag of cement per cubic yard.

The design of the mix will conform to the following conditions:

a. If ready-mix concrete is to be used from an established plant where the current mixes have been designed by a testing laboratory, the operator will submit the plant design. This mix must fall within the master limits in Table I.

b. When operator is operating a batch plant, the design mix will be determined by an approved laboratory at the expense of operator and submitted to Forest Service for review and approval.

c. The mix will be designed so that the slump determined in accordance with ASTM Designation C-143-66 will be no less than 2 inches or more than 4 inches, except seal concrete shall be no less than 4 inches or more than 8 inches.

d. Determining the Proportions and Batch Weights. The proportions and batch weights will be determined as prescribed in 1, 2, and 3 below.

1. Trial Mixes. The testing laboratory will determine the proportions on the basis of trial mixes made with the materials to be used in the work, the corresponding cement content being determined by means of a yield test in accordance with ASTM Designation C-138-63. The proportions will be such as to require (within a tolerance of 2 percent) the cement content shown in Table I as the minimum cement content for the particular size of aggregate being used.

2. Proportions. the testing laboratory will then designate the weight in pounds of fine and coarse aggregate in saturated surface-dry condition per bag (94 pounds) of cement, the cement content in bags per cubic yard, and the gallons of water and amount of air entraining agents per bag of cement.

3. Batch Weights. The testing laboratory will also designate the batch amount of each ingredient in pounds, except that the amount of water may be designated in gallons. Since the proportions are designated in terms of aggregate in saturated surface-dry condition, the equivalent batch weights of aggregates to be used by operator will have to be corrected periodically to take into account the actual moisture content of the aggregates at time of use. The batch weights, corrected for actual moisture, shall not be changed by operator during the progress of the work without approval by Forest Service.

Materials

2.1 Cement. Portland cement of only one brand shall be used throughout the contract. The Portland cement shall conform to the requirements of ASTM C - 175-Air-entrained.

2.2 Water. The water used in concrete will be subject to approval and will be free from objectionable quantities of silt, organic matter, alkali, salts, and other impurities.

2.3 Admixtures. Admixtures shall not be used without written permission unless elsewhere provided for in these Specifications or in the Supplemental Specifications.

a. Air entraining admixtures complying with ASTM C-260-66T shall be used to entrain the appropriate percent of air shown in Table I.

b. When the use of calcium chloride is permitted or is specified, it shall comply with ASTM Designation D-98-59.

2.4 Sand and Coarse Aggregate. All aggregate shall be furnished from an approved source and shall comply with ASTM Designation C-33-67.

2.5 Premolded Filler for Expansion Joints. Filler shall be of bituminous (asphalt or tar) mastic composition conforming to ASTM Designation D-994-53.

2.6 Bar Reinforcement. Bar reinforcement shall be ASTM Designation A615-68, Grade 40 to Grade 60 steel as called for on Drawings or in the Supplemental Specifications.

a. Tests. If purchased in small lots from a warehouse, reinforcement may be accepted, subject to the bending tests.

2.7 Welded Wire Fabric Reinforcement. Steel wires fabricated into sheets (mesh) shall conform to ASTM Designation A185-61T.

Construction Methods

3.1 The operator shall give Forest Service a 24-hour notice prior to placement of any concrete.

3.2 Forms. Forms shall be used, wherever necessary, to confine the concrete and shape it to the required lines. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall be maintained rigidly in position. Forms shall be mortar tight.

Chamfer strips shall be placed in the exterior corners of forms so as to produce a 3/4-inch beveled edge on permanently exposed concrete surfaces. Forms shall be made of or lined with plywood, hardpressed fiberboard, finished lumber, or metal. Before concrete is placed, the surfaces of the forms shall be oiled with a commercial form oil.

3.3 Batching and Mixing. The sand and coarse aggregate shall be weighed and proportioned on the basis of whole sacks of cement unless the cement is weighed. Purchaser shall provide, maintain, and operate the

equipment as required to accurately determine and control the amount of each ingredient in the concrete. Batching shall be such that combined inaccuracies in feeding and measuring the materials will not exceed $1\frac{1}{2}$ percent for water and weighed cement and 2 percent for sand and each size of coarse aggregate. The concrete shall be uniform in composition and consistency throughout the mixed batch, and from batch to batch, except where changes in composition or consistency are directed. Mixing shall conform with the Standard Specification for Ready Mixed Concrete, ASTM Designation C-94-68. No mixer with rated or working capacity of less than a one-bag batch shall be used.

3.4 Ready Mixed Concrete. When the operator elects to use ready mixed concrete, it shall comply with all of the requirements of this Specification.

3.5 Hand Mixing. Hand mixing will not be permitted except in case of emergency and with written permission from the Forest Service. When permitted it shall be performed only on watertight platforms. Hand mixed batches shall not exceed $\frac{1}{2}$ cubic yard in volume. Hand mixing will not be permitted for concrete that is to be placed under water.

3.6 Preparations for Placing. All surfaces upon which concrete is to be placed shall be free from standing water, mud, and debris. Earth foundations shall be free from frost or ice when concrete is placed. The surface of absorptive foundations shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete. The surfaces of construction joints shall be clean, rough, and "saturated by water," when covered with fresh concrete. Cleaning shall consist of the removal of all laitance, loose or defective concrete, coatings, sand, sealing compound, and other foreign material.

The methods and equipment used for transporting concrete and the time that elapses during transportation shall be such as will not cause appreciable segregation of coarse aggregate or slump loss in excess of 1 inch in the concrete as it is delivered into the work. Retempering of concrete will not be permitted. Any concrete which has become so stiff that proper placing cannot be assured shall be wasted. Formed concrete shall be placed in continuous, approximately horizontal layers, the depths of which generally shall not exceed 20 inches.

Dropping the concrete a distance of more than 5 feet or depositing a large quantity at any point and running or working it along the forms will not be permitted.

3.7 Vibrating. Unless otherwise approved, the concrete shall be consolidated with suitable vibrators operating within the concrete. Vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate consolidation, especially around obstructions.

Vibrators shall transmit vibrations to the concrete at frequencies of not less than 5,000 impulses per minute. Vibrators shall be so manipulated as to work the concrete thoroughly around reinforcement and imbedded fixtures and into corners and angles of the forms. Vibrators shall not be used as a means to cause concrete to flow or to run into position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish thorough consolidation, but shall not be prolonged to the point where segregation occurs.

3.8 Underwater Concrete. Concrete deposited in water shall be "Seal Concrete." To prevent segregation, concrete shall be carefully placed in a compact mass, in its final position, by means of a tremie, a bottom dump bucket, or other approved method, and shall not be disturbed after being deposited.

Concrete shall not be placed in running water. The forms for underwater concrete shall be constructed to provide still water within. The concrete shall be placed continuously until the required depth is reached, keeping the surface of the concrete as nearly level as possible during placing. If a tremie is used, the placing shall comply with the following requirements:

A tremie shall consist of a water-tight tube having a diameter of not less than 10 inches with a hopper at the top. The tube shall be equipped with a device that will prevent water from entering the tube while charging the tube with concrete. The tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering, when necessary to retard or stop the flow of concrete. The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall contain sufficient concrete to prevent water entry. When concrete is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete.

3.9 Cold Weather Concreting. Unless approved by Forest Service, the mixing and placing of concrete shall be discontinued when the atmospheric temperature is below 40°F., in the shade and is falling and shall not be resumed until the atmospheric temperature is 40°F., in the shade and rising. If written authorization is granted for the mixing and placing of concrete when the atmospheric temperature is below 40°F., the concreting operations shall meet the following requirements:

Concrete shall have a temperature of not less than 60°F., and not more than 80°F., at the time of placing. Aggregates shall be heated uniformly to prevent degradation, to maintain consistent moisture, and to eliminate ice and frozen lumps. The average temperature of an individual batch of aggregate and the temperature of the mixing water shall not exceed 150°F.

The temperature of the concrete shall be maintained at a minimum of 50°F., for 7 days or 70°F., for 4 days after placement.

Concrete may be cured underwater if the temperature of the water does not fall below 35°F., and at least 6 inches of water is maintained over the concrete for a minimum of 10 days.

If the structure is enclosed, combustion heaters shall not contact the surface of the concrete and shall be vented to the outside of the enclosure. The maximum temperature within the enclosure shall not exceed 120°F., when the concrete is protected by any means other than steam.

3.10 Curing Concrete.

a. General. Concrete shall be cured either by water curing or by membrane curing except as otherwise provided. The unformed top surfaces of walls and piers shall be moistened by covering with water-saturated material or by other effective means as soon as the concrete has hardened sufficiently to prevent damage. These surfaces and steeply sloping and vertical formed surfaces shall be kept completely and continually moist, prior to and during form removal, by water applied on the unformed top surfaces and allowed to pass down between the forms and the concrete faces. This procedure shall be followed by the specified water curing or membrane curing.

b. Water Curing. Concrete cured with water shall be kept wet for at least 7 days immediately following placement of the concrete. Water curing of concrete may be reduced to 6 days when the mean daily temperature is less than 40°F., to conform with ACI Standard of 604-56, "Recommended Practice for Winter Concreting." When water curing, the period of protection from freezing must be the same as the required period of water curing.

c. Membrane Curing. Membrane curing shall be by application of a sealing compound which forms a water-retaining membrane on the surface of the concrete. The sealing compound shall be white pigmented and shall conform to ASTM Designation C-309-58.

Sealing compound shall be applied to the concrete surfaces by spraying in one coat to provide a continuous uniform membrane over all areas. Areas covered by 1 gallon shall not exceed 150 square feet, and on rough surfaces, that area shall be decreased as necessary to obtain the required continuous membrane. When sealing compound is used on unformed concrete surfaces, application of the compound shall commence immediately after finishing operations are completed. When sealing compound is to be used on formed

concrete surfaces, the surfaces shall be moistened with a light spray of water immediately after the forms are removed and shall be kept wet until the surfaces will not absorb more moisture. As soon as the surface film of moisture disappears, but while the surface still has a damp appearance, the sealing compound shall be applied. Special care shall be taken to insure ample coverage with the compound at edges, corners, and rough spots of formed surfaces. After application of the sealing compound has been completed and the coating is dry to touch, any required repair of concrete surfaces shall be performed. Each repair, after being finished, shall be moistened and coated with sealing compound in accordance with the foregoing requirements.

3.11 Removal of Forms and Falsework.

a. Falsework and forms shall remain in place under slabs, beams, and girders for 14 days after the day of the last pour, except as set forth in 1 and 2 below:

1. When high-early strength cement is used, forms for all structures may be removed after 4 days.

2. In cold weather, the length of time that forms and falsework are to remain in place shall be determined by test cylinders cured at the site.

b. To facilitate finishing, all other forms should be removed in not less than 12 or more than 48 hours, depending on weather conditions.

3.12 Finishing Concrete. All concrete shall be finished in accordance with either a, b, or c below:

a. Ordinary Finish. Unless otherwise shown on Drawings or as indicated in b or c below, all concrete shall be given an ordinary finish. An "ordinary finish" is defined as the finish left on the surface after the removal of forms, the filling of all holes left by form ties, and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections.

b. Concrete Slabs. Immediately after being poured, concrete slabs shall be struck off with templates to provide proper crowns and shall be hand finished to smooth, even surfaces by both longitudinal and transverse movement of wooden floats, or by other suitable means. Final finish shall be slightly, but uniformly, roughened by brooming or other methods as directed by Forest Service. A finished surface shall not vary more than 1/8 inch from a 10-foot straightedge placed parallel to the centerline of the roadway. No variations that will prevent complete drainage on all parts of the deck will be permitted.

c. Curbs and Sidewalk Surfaces. Exposed faces of curbs and sidewalks shall be finished to true surfaces. Concrete shall be worked until coarse aggregate is forced down into the body of the concrete and a thin layer of mortar is flushed to the top. The surface shall then be floated to a smooth but not slippery finish.

3.13 Repair of Concrete. All porous and fractured concrete shall be removed by chipping openings in the concrete, and the chipped openings shall be repaired with epoxy mortar or non-shrink grout. The presence of areas of excessive honeycomb may be considered sufficient cause for rejection of a structure.

Reinforcement

3.14 All reinforcement shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust when placed.

When bending is required, the reinforcement shall be bent accurately without the use of heat. Bars having cracks or splits at the bends shall be rejected. All reinforcement shall be placed in the exact positions shown on Drawings, and shall be held so securely in position by wiring and blocking from the forms and by wiring or spot welding together at the intersections that it will not be displaced during the depositing and compacting of the concrete. Precast concrete blocks or approved chairs should be used where appropriate. The use of pebbles or wood for blocking is prohibited.

The placing and fastening of reinforcement in each section of the work shall be approved before any concrete is deposited in the section when bar-bending diagrams are not shown on the contract drawings.

Detail Drawings showing the shapes to which reinforcing bars will be bent shall be submitted for approval.

3.15 Splicing Reinforcement. Main reinforcing bars carrying determinate stresses shall be spliced only where shown on Drawings, unless approval for splicing is obtained before the reinforcing steel is ordered.

unit

list of references



PART V

LIST OF REFERENCES

LIST OF REFERENCES

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- DOT-F.R.-Vol. 35, No. 161, Part 192 - Department of Transportation
Federal Register, Volume 35, Number 161, Part 192, Transportation
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- API-1105 - Bulletin on Construction Practices for Oil and Products
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- API-Sta.5LR - Specification for Glass Fiber Reinforced Thermosetting
Resin Line Pipe - 1968.
- Koch Products Co., Technical Bulletin, Blue Streak Line Pipe Brochure.
- Koch Products Co., Technical Bulletin, Installation Procedures
Applicable to 6", 8", and 10" Koch Blue Streak Pipe - 1970.
- Koch Products Co., Koch Sales Manual, General and Product Information
Section.

REFERENCE ORGANIZATIONS

ANSI - American National Standards Institute, Inc.
1430 Broadway
New York, NY 10018

DOT - Department of Transportation
Hazardous Materials Regulations Board

API - American Petroleum Institute
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Washington, D. C. 20006

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